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THE

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VACUUM TUBE LIGHTING.

"SUNSHINE at will—the luminous ether harnessed by the Wizard Edison—blazing vacuum tubes—electricians' race is won, and the laurels are at Menlo Park—invisible X rays are transformed into beautiful sunlight at his touch. American genius again triumphant." Such are the sensational headlines to an article in the *New York World* on Edison's latest invention. Edison has again licked Creation; at least, it is difficult to conceive how the *New York World*, if it had been there, could have announced that historical event in more sensational terms.

Edison, however, is not the only inventor nor the first who has in recent years attempted to get an economical light from the "blazing vacuum tube." We do not intend to enter here into a complete history of the subject, but we may remind our readers that Tesla, among his remarkable experiments with high-frequency high-tension currents in 1891 showed a lamp in which a small light was given out by a carbon button set aglow in a vacuum bulb. In 1894 Ebert startled the scientific world by announcing that he had succeeded in obtaining a serviceable light with the expenditure of one-millionth part of a watt. This extraordinary result does not appear to have survived hostile criticism. Neither Tesla's nor Ebert's lamps were of sufficient candle-power to be commercially valuable.

Ebert's lamp appears, however, to have contained the germ of the idea which Edison has now utilised in his "blazing vacuum tube." In Ebert's lamp resonant high frequency currents were supplied to annular electrodes outside a vacuum bulb. Cathode discharges produced inside the bulb by these electrodes, were focussed on a button of phosphorescent material at the centre of the bulb, and from this button a brilliant white light was given out.

Edison's recent investigations on the Röntgen rays appear to have led him up to Ebert's idea of utilising the luminescence produced by the cathode discharge on suitable substances inside the vacuum tube, and we have no doubt he has been able to produce lamps of much greater candle-power than Ebert's. His own researches, and those of other investigators, have made him better acquainted with the kind of vacuum, and the best substances to be used to produce the maximum phosphorescence inside a vacuum tube; and no doubt Edison has utilised these discoveries to produce a much more powerful luminescent lamp.

The description in the *New York World*, already referred to, gives very little detail, though it is not difficult, by reading between the lines, to guess how the lamp is made. Edison coats the inside of a Röntgen tube with a phosphorescent substance. The composition of this substance is at present kept secret, and it is said not to be tungstate calcium, the substance which Edison has hitherto recommended as the best. When Edison announced his discovery of tungstate of calcium, it was stated in our columns—on the

authority of Mr. Jackson—that the tungstate of calcium did not under the influence of the X rays give more than 50 per cent. of the luminosity emitted, under the same conditions, by potassium platino-cyanide. Edison has probably by this time discovered this fact, and we should not be surprised to find that it is the principal constituent of the lining of his "blazing vacuum tube."

We turn now to the glowing description of Edison's new lamp by the *New York World* reporter:—

The room was absolutely dark. Mr. Edison stood by a table on which were the primary and secondary induction coils used in the transformation of the ordinary electric current into X rays. He touched the little switch, and instantly the room was filled with a pale blue light of pellucid softness that did not dazzle the eye. It was not the sickly yellow of the incandescent nor the blinding flash of the arc lamp. It was more like the luminous blue that the modern school of impressionist painters strive to throw over their landscapes—the colour they assert to be the true sunlight.

At first the light was not strong. "We'll put on more current," said Mr. Edison, "and run it up as high as the lamp will stand."

Outside the room an assistant was standing at the strip of incandescent lamps which are inserted in the circuit to pile up resistance. The electricity they use prevents too strong a current running into the X ray bulb.

"Take out two lamps," called Mr. Edison. The little bulb in the dark room glowed more brilliantly.

"Two more," he cried. The wizard was intently watching the results.

"More, more!" he exclaimed. "Six, eight, ten!"

Brighter and brighter flashed the bulb each time until, with all the resistance lamps out of the circuit, it radiated the most brilliant light that Mr. Edison had yet succeeded in obtaining. Then it gradually began to fade, until it remained at about half its maximum.

"The crystals have cracked as usual," said Edison, "and air has entered. The frosting substance on the inside of the bulb is composed of minute crystals. They chip and break just like the crystals of a diamond. Under the pressure of the vacuum (*sic*), with the added bombardment of the X rays against them, they break, and allow the minute particles of air they contain to escape. This serves to destroy the vacuum, and causes the dimming of the light. In a few days, however, I shall be able to get the bulbs coated so perfectly that the vacuum will not be affected."

Edison goes on to say that a globe 6 inches in diameter will give 8 candles, and that the best commercial lamp at present in use requires three and a half times the amount of energy per second required in this lamp.

Granting all this to be true, and we see no reason to doubt it, we fear that the defect which Edison has already discovered in his experimental lamp, namely, the want of permanence, will hardly be got over, and of course will, in that case, be fatal to the commercial development of this idea. Crookes long ago found that substances rapidly lose their power of phosphorescing under the continued action of the cathode discharge. This we believe to be the true explanation of the gradual extinction of Edison's glowing crystals, and it is hard to see how he is to get over the difficulty.

Another American inventor, Mr. D. McFarlan Moore, has recently achieved considerable success in vacuum tube lighting, though on somewhat different lines from Edison. Mr. Moore's system has already been several times noticed in our columns. Some parts of his apparatus are characterised by great ingenuity and originality, and at a recent meeting of the American Institute of Electrical Engineers he succeeded in illuminating the auditorium with less expenditure of power than is required by the 25 incandescent lamps with which it is regularly lighted:—

According to the *New York Evening Post*:—

Mr. Moore's method, as shown that memorable night, was to run tubes of glass around the room, each tube being about 7 feet in length and an inch in diameter. The rarefied air in these tubes he brought up to a point of luminescence by means of a little "vibrator," consisting simply of a spring in a tiny glass tube, the play of which was governed by a small electro-magnet outside the tube. The current from the dynamo in passing along the circuit of the big lighting tubes causes the little electro-magnet to vibrate a few hundred times a second, and the reactive effect of the magnet is to cause the current to be broken up, or "vibrated," at a very high rate, with such effect that the electric agitation of the air in the tube necessarily results in light.

Mr. Moore does not, like, Edison, obtain his light from a phosphorescent solid, but from the glowing of the gas in a tube with comparatively low vacuum. It is well known that in the process of exhausting a tube a point of maximum luminosity of the residual gases is reached long before the Crookes or Röntgen vacuum is attained. This is evidently the point up to which Mr. Moore exhausts his tubes. His vacuum interruptor is evidently peculiarly well adapted for producing the best kind of current for evoking this luminosity in his tubes.

Considerable difference of opinion appears to exist among American engineers as to the efficiency of Moore's system, and evidently careful experiments will be required to settle the question. The tendency of the rarefaction of vacuum tubes to increase when powerful discharges are sent through them, appears to us to be the greatest objection to Mr. Moore's system. It would be impossible, for this reason, to keep the vacuum for long at the point of maximum luminosity, without complicated devices for admitting air. Mr. Moore has sent us a fully exposed photograph of the auditorium of the Institute of Electrical Engineers, taken by his vacuum light, with an exposure of 30 seconds; so there can be no doubt that the candle-power of his light is amply sufficient for domestic lighting.

Tesla has also recently made a great advance in vacuum tube lighting, though detailed description of his invention does not appear to have been published. The New York *Electrical Review* states that he has constructed a vacuum tube, without electrodes, having a volume of 90 cubic inches, capable of giving approximately a light of 250 candles. The same journal reproduces a fully exposed photograph of the inventor, taken by this lamp, with an exposure of 2 seconds.

Whether these three American wizards are to revolutionise our systems of lighting remains to be seen; we think ourselves that there is no occasion for a panic in gas or incandescent lamp shares. The practical difficulties to be overcome appear as yet to be legion, and we would remind inventors of the apparently unimportant but well established depilatory action of the X rays. If the light of the future is to be charged with X rays, how are we to to keep our hair on?

IRON LOSSES IN TRANSFORMERS AND P.D. WAVES.

The paper on "Experimental Tests on the Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses of Transformers" recently read before the Institution of Electrical Engineers by Messrs. Beeton, Taylor and Barr, is the most complete and careful examination of this very difficult subject that has so far appeared. Many papers or

articles have been published dealing with this subject, but most of them have been of a purely theoretical character, while others which have dealt with experimental results have been based on somewhat limited observations. The authors of this, the latest paper, have approached the subject quite in the right spirit, having apparently realised the fact that the variations in wave-forms found in practice render mere mathematical examination of little use—they have therefore gone to work in the manner hitherto characteristic of American rather than of English practice, entirely on the basis of experiment. Even if they had not given us their further experimental results they would have done good service by drawing renewed attention to what cannot fail to be a very useful tool—we refer to what they term an "injector." This apparatus enables them, by very simple means, to alter the form of wave, and so to try the effect of a far greater variety of wave-forms that would be practically possible by any other known practical method. The injector consists of a kind of simple commutator, by means of which any desired resistance or capacity may be thrown into circuit during any portion of each half period, thus enabling the wave to be trimmed up to shape as required. It is, we gather, not proposed to apply such an apparatus to central station practice (our borough electrical engineers will be relieved to learn), but only to use it for laboratory purposes. We think the idea decidedly novel and useful, and congratulate the authors on it. To what extent it is likely to be used by designers of alternators we have no idea; but even if (as is probable) it is not used by them at all, it cannot fail in assisting experimental investigations.

This whole subject of the best form of P.D. wave has been very considerably discussed, and at one time it appeared possible that those consulting electrical engineers who aimed at imposing on contractors the maximum possible difficulty would see fit to insert in their specifications clauses binding them under penalty to supply alternators giving some particular variety of curve. But this is not yet—the state of uncertainty of mind revealed by some of the references cited by the present authors appearing to show that for the present, at least, consulting engineers are unlikely to commit themselves on the subject.

And here we would draw the attention of the authors of the paper, and all others whom it may concern, to what seems to us to be a gap in the records of the subject. We have the results of experiments made in laboratories on the one hand—results obtained by tests on transformers drawing their energy from alternators of various sorts, some giving curiously irregular curves, some curves of a uniform sinusoidal form, such as must delight the heart of authors of papers whose calculations have always assumed such sine curves. But we have, so far as we can call to mind, no investigation showing what effect is produced on the form of waves by the very various conditions of large supply systems. When we consider the possible effect of capacity, of self-induction, of hysteresis (magnetic or dielectric), of leakage, of the reactions of motors, and of the interactions of alternators running parallel and interfering with one another—all these things, and others, found in connection with large distribution systems—we are fain to enquire how much of the original peculiarities of the generated waves is left, and what is the practical importance to central station coal bills of the form of those generated waves.

This is a subject the authors may well take up. By doing so, they will add to the undoubted usefulness of the results obtained by pure laboratory research.

John Worrel Keely.

In a recent issue of the *Metropolitan Magazine* there is a pleasantly appreciative paper by J. S. Paston, on John Worrel Keely and that mysterious force of his which so excites the derision of scientists, and did (about 21 years ago) attract so much hard cash from some of the hard headed business men over in America. The paper is illustrated with photographs taken in Keely's laboratory, and there is one of this wonderful man himself, surrounded by his "instruments for capturing the *elusive* etheric force." The face is of a particularly mild and inoffensive type—the sort of face that might belong to those thousands of whom it might be said they were born men and died grocers. However, we have no quarrel with this worthy's personal appearance. Mr. Paston has been lucky enough to see Keely and inspect his work-shop, and even to see that wonderful motor, which for 21 years has so persistently "refused to mote." The criticisms of the writer are very much on the same lines as those of our own when we have had occasion to comment upon Keelyism. He refers to that extraordinary nomenclature, which J. W. K. has coined, as the most arrant nonsense to the uninitiated ear, though it may be the wisdom of Solomon in essence. Mr. Paston's request for a simple explanation of such terms as "quadruple negative harmonies," "atomic triplets," &c., was met with replies which led him to think that Keely's business backers know but little more than the average mortal about the whole matter. Keely himself is as lucid as his disciples. What Keely does, says Mr. Paston, is to reiterate the accepted atomic and molecular theory of chemistry, but he veils it behind an abstruse and ponderous verbiage. It is something to have discovered this, and Mr. Paston must have spent many weary hours in arriving at it. For ourselves, after a close study of all the writings which may be described as the literature of Keelyism, we have been unable to arrive at any conclusion as to what Keely has done, does, or is going to do. Mr. Paston, however, says that when the man succeeds in controlling his mysterious force, he intends to do a few of the following feats:—He will divest matter of weight so that it can be moved in any quantities from place to place; he will thus, we presume, facilitate building operations, and the "faith that moves mountains," will not be required any more, for inconveniently situated eminences will be divested of their weight and sent to fill up inconveniently situated hollows—the Irish Sea for example. He will "dissociate enough etheric force" from "a small quantity of air" to run the whole of the world's machinery, thus vanishing the cruder forces derived from water and coal. The dissipation of cyclones, the instantaneous disintegration of rocks and minerals are also on the programme. Of the pictures (photographs) there is only one of which we can give any coherent description, it is that of the Keely vibratory switch. This looks like a small cart-wheel, the outer edge of which is studded all over with buttons, on which are written what appear to be the signs of the zodiac and other hieroglyphics; then comes a circle of (apparently) magnetic needles, most of which are placed radially, and then four spokes radiating to the thick rim from the axle. Mr. Paston must have got on very well with Keely, for he permits him to reproduce a photo of "Keely's graphic chart." It is the alleged key to the secret of his discovery, and is the essence of simplicity as anyone can see at a glance. At least anyone will say so rather than daze his visual organs by a second look at it.

COMPUTATIONS FOR COIL WINDING.

By W. SLINGO and A. BROOKER.

(*Concluded from page* 716.)

It may be remarked that the number of convolutions, N, may be more accurately determined by finding the number of convolutions per layer $\frac{l}{d}$ and the number of layers $\frac{t}{d}$ separately, and multiplying together the numbers so obtained, than by using formula (1) directly. Any fraction obtained when dividing by d should, of course, be discarded. This point is, however, only important when the wire is of comparatively large diameter and the bobbin small.

If we wish to calculate the resistance, R, which a coil of wire will offer when wound on a given bobbin, it is better to first find L (inches) as above, and take from a table the resistance per foot, r, of the wire employed; then

$$R = \frac{L \times r}{12} \text{ ohms.}$$

It is frequently necessary to determine the diameter of the wire which can be wound into the form of a coil which shall fill a bobbin of given dimensions and offer a given resistance. We will first take the case in which the insulating covering of the wire is so thin, compared with the diameter of the wire, that it may be neglected, although it must be remembered that a very great error may thus be introduced in the case of thin wires, because then the insulating covering occupies a considerable proportion of the space.

There are two unknown quantities, L, the length of the wire, and, d, its diameter. The wire occupies as much space as if it were square in section, the length of the side of the square being d; and the whole space or volume, V, occupied by the wire, no matter whether it is straight or coiled, is evidently

$$V = L \times d^2,$$

therefore

$$d^2 = \frac{V}{L} \qquad (4)$$

The value of V, or the space on the bobbin available for wire is

$$V = l\left(\pi \frac{D_1^2}{4} - \pi \frac{d_1^2}{4}\right) = \frac{\pi\, l}{4}(D_1^2 - d_1^2).$$

The resistance, R, of the wire is equal to its length multiplied by its specific resistance, s, divided by its sectional area,

or

$$R = \frac{L \times s}{\text{area}} = \frac{L \times s}{\pi \frac{d^2}{4}}$$

that is

$$R = \frac{4\, L\, s}{\pi\, d^2} \qquad (5)$$

The specific resistance, s, is in this case taken as the resistance between the faces of an inch cube of the metal; this resistance for copper is $0{\cdot}0000006754^{\omega}$, and for German silver it averages $0{\cdot}0000084^{\omega}$ at 60° F.

From equation (5) we find

$$d^2 = \frac{4\, L\, s}{\pi\, R}$$

and combining this with equation (4)

$$\frac{4\, L\, s}{\pi\, R} = \frac{V}{L}$$

whence

$$L^2 = \frac{\pi\, R\, V}{4\, s}$$

or

$$L = \sqrt{\frac{\pi\, R\, V}{4\, s}} \qquad (6)$$

Having thus found L, we at once get the diameter of the wire from equation (4).

As we have remarked, however, the assumption that the space occupied by the insulating covering is so small that it may be neglected, is likely to give rise to a considerable error in the case of thin wire. If the thickness of the insulating covering were an unknown and variable quantity, it would be somewhat difficult to make the necessary calculations, but, as a matter of fact, this dimension is always known in practice. For example, we know whether we intend to use wire which has a single or double covering of silk, or of cotton, and the thickness of such a covering is the same no matter what the diameter of the wire may be. This fact is usually overlooked by the constructors of formulæ. If we represent the thickness of the covering by y, the increase in diameter, due to the insulating covering, is $2\,y$, and

$$d = \delta + 2\,y,$$

where δ is the diameter of the conductor, and d the diameter over all as before.

Then

$$V = L\, d^2 = L\,(\delta + 2\,y)^2$$

$$L = \frac{V}{(\delta + 2\,y)^2} \qquad (7)$$

In the equation representing the resistance, R, which has been decided upon for the particular coil, the diameter of the conductor only must be taken into consideration, thus

$$R = \frac{4\, L\, s}{\pi\, \delta^2}$$

$$L = \frac{\pi\, R\, \delta^2}{4\, s} \qquad (8)$$

By combining (7) and (8) we obtain

$$\frac{V}{(\delta + 2\,y)^2} = \frac{\pi\, R\, \delta^2}{4\, s}$$

from which

$$\delta^2\,(\delta + 2\,y)^2 = \frac{4\, V\, s}{\pi\, R} \qquad (9)$$

If preferred, the value of V may be inserted in terms of the dimensions of the bobbin as given above, and then the equation becomes

$$\delta^2\,(\delta + 2\,y)^2 = \frac{l\, s}{R}\{D_1^2 - d_1^2\}$$

$$\delta\,(\delta + 2\,y) = \sqrt{\frac{l\, s}{R}(D_1 + d_1)(D_1 - d_1)}. \qquad (10)$$

In applying this formula it will be better to first find the value of the expression on the right-hand side of the equation, and then calling this quantity Q,

$$\delta\,(\delta + 2\,y) = Q$$

$$\delta = \sqrt{Q + y^2} - y \qquad (11)$$

As Q and y are known quantities, this formula gives δ the diameter in mils of the *conductor* of the insulated wire which will fill the bobbin of given dimensions and offer a resistance of R ohms.

The length of the wire required can, of course, be found from the equation

$$L = \frac{V}{d^2}$$

where

$$d = \delta + 2\,y.$$

Although some of these formulæ may appear cumbersome, the results can be obtained with great ease by means of a table of logarithms, and it will be observed that in several instances it is possible to insert constants which will facilitate the operations. It must be remembered that it is very difficult to wind on a bobbin the maximum amount of wire which the bobbin can possibly hold, and a slight allowance should always be made for irregularity in winding as well as for possible variations in the diameter of the wire. It is usually found convenient to make this allowance by slightly reducing the value of V, the volume obtained by measurement of the bobbin; if too great an allowance has been made the wire does not quite fill the bobbin, but this is far less inconvenient than to find that it is impossible to get the whole of the wire on the bobbin.

It will rarely happen that the value of δ, the diameter of the wire found by calculation will be exactly equal to the diameter of one of the standard sizes of wire in common use. It is necessary to select the standard size next below that calculated, cut off a sufficient length, and after the wire has been wound, to measure the resistance of the coil, say, with a Wheatstone bridge, cutting off short lengths until the exact resistance required is arrived at.

A COMMUTATOR FOR STORAGE BATTERIES.*

By W. M. STINE.

A few designs for connecting storage batteries for testing purposes have appeared at intervals, and elicited such interest that it may not be amiss to add another one to the list. The storage battery is an indispensable adjunct to the electrical laboratory or testing room. The extremes of such service demand the cells shall be coupled all in series or in multiple. Then frequent necessities require that various intermediate combinations be made for current or electromotive force. In fact, such purposes necessitate that the entire battery be available in individual cells or in groups. The proper grouping must also be provided for when charging the cells.

During the recent Columbian Exposition the writer designed a commutator for a battery of 60 cells for use in the tests of apparatus made by the Electrical Jury on Awards. It proved so satisfactory that a second one was constructed for the galvanometer laboratory at Armour Institute of Technology. The following description is based on this construction. The battery of 60 100-ampere hour cells is placed in a tight closet, the commutator being attached to this in a convenient position. The poles of each cell are connected independently to the commutator, wire of No. 8 gauge being used.

Though the number of conductors, 120 in all, is large, the mass of wire is by no means bulky when arranged in an orderly manner. The commutator is constructed of maple, 2 inches thick, and is 6 feet 3 inches over all, and 6¼ inches in width. It is made in three sections, the centre one containing the mercury cups, the outer ones the mercury troughs.

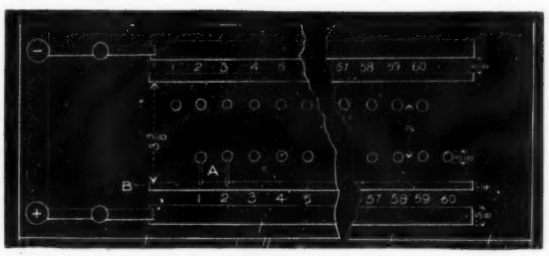


Fig. 1.

The division line is at B, fig. 1. The sections are held together by dowel pins. The mercury cups are simply ⅜ inch holes drilled to a depth of 1½ inch. The centres of the cups are ¾ inch apart. The cups are in two rows, 2 inches apart, and while the cups are opposite each other the rows are staggered, so that a cup in one row is opposite its next serial number in the other. In the drawing, B indicates an open slot for connecting the wires. The mercury troughs are ⅝ inch wide and ¾ inch deep, and their length is readily determined from the drawing. A copper strip ¼ × ½ inch is screwed in the bottom of each trough, to lower the resistance and lessen the amount of mercury required. To the left are two heavy copper strips, to which several sets of binding posts are attached. Each mercury cup is appropriately numbered as shown. To connect the cups with the poles of the cells, short pieces of copper wire are bent, as shown in A, fig. 1. The outer ends are soldered to strips of No. 18 copper, ½ inch wide. These strips are nailed to the sides of the central section, and the wires from the cells are soldered to them. It was to facilitate this operation that the commutator was made in three sections. In fig. 2 it will be noticed that the distance from the mercury cup to the trough is the same as the space between the rows of cups. The connections for manipulating the commutator are cut from No. 6 copper wire.

One of the leading features in the design was to prevent the possibility of short-circuiting a cell. This was accomplished by staggering the rows of cups, and spacing them so the connections could not be misplaced.

The cells are charged from 110-volt mains by connecting them in two groups of 30 cells each. This is accomplished by placing connectors in holes 1 and 31, and 30 and 60, and using series connectors between the cells. Any possible grouping of series, multiple or multiple series can be readily effected. The grouping for a multiple-series of two cells each is indicated in fig. 2. This is of the greatest service for calibrating ammeters, while for voltmeter calibration, cable testing, photometry of incandescent lamps, and such work the proper series combinations can be made in a few moments. If the same grouping is to be made repeatedly, the connectors may be permanently mounted on rods.

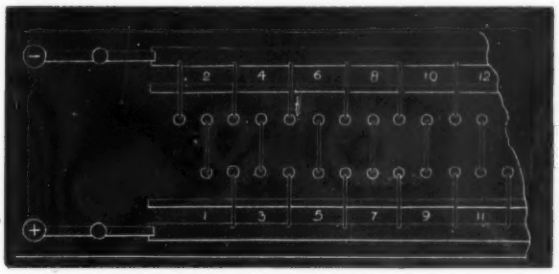


Fig. 2.

This device has another great advantage. When a number are using the same battery for testing, separate cells or groups may be used simultaneously by inserting wires in the cups themselves. When a battery is used for testing, it is almost impossible to distribute the service equally among the cells, some must inevitably be used more than others, and since the battery must be charged as a whole, the overworked cells should receive individual charging. To provide for this, a bank of five incandescent lamps has been placed above the commutator. These are fitted in key sockets, and so connected that cells may be placed in series with them through wires dipping into the mercury cups. This arrangement is entirely satisfactory.

It is evident that the design of the commutator is adapted for any number of cells. It is also advisable to use a hinged lid over the whole commutator to keep the mercury clean.

Armour Institute of Technology.

* New York *Electricity*.

COOLING SYSTEMS FOR CONDENSING WATER.

To judge by an article in *Cassier's Magazine*, by Mr. Starkweather, the systems of cooling condensing water, as practised in California, are crude and cumbersome. Yet the gain by condensation is usually so great that one would have thought greater attention would have been paid to the matter. It is so common to hear the excuse put forward for the use of non-condensing engines that there is not sufficient water to condense with, that it is clear not much is generally known of the data relating to cooling. Yet an atmospheric condenser will give a fair vacuum, and use no more water than a non-condensing engine blowing its exhaust to the atmosphere. The paper names three systems—by pools, *i.e.*, the ordinary condensing ponds, by shallow pans or trays, and by sprays. The first is, of course, only suited for an ample space, and the ponds almost always leak a lot of water to waste. Moreover, there is a tendency for them to foul quickly. In the pan or tray system there is expense, and much space is needed. The trays are shallow, of iron or wood, and 2 to 4 feet wide, and they are apt to foul and become leaky.

The spray system is advocated as most efficient, the discharged water from the condensers being simply sprayed in fine showers, and thus exposed in a finely divided state to the air. Several examples of coolers on the various systems in California are given, the lowering of the temperature being, in good examples, 40°. It would seem that in the pond system 30 square feet of surface should be allotted to each indicated horse-power; in the tray system 20 feet. No

mention is made of the fan and tower system. We believe that by means of a tower filled with cellular woodwork, over which water runs by gravity in thin films, the area of ground space is only 1 per cent. of that of a pond. Air is blown into the base of the tower by a fan, and carries off the heat in the water vapour it sweeps with it. An open air cellular system exposed to the wind is found very effective. One such is visible from the Great Western Railway, near Southall, and appears to consist of a series of vertical boards, fed by water from above, and hung in a frame, the boards being a few inches apart, and in two heights of a total of about 20 feet, the boards of the lower tier being at right angles with the upper tier boards, so that one or other tier exposes its board's edge on to the wind, when the other tier is flat to it, so ensuring even action. We believe this system is effective. It immensely multiplies the ground plan area available, and its construction is of cheap materials, and there are few tight joints to make, the water being simply distributed from a perforated upper trough extending full length of the structure, into narrow troughs made by nailing a pair of boards along each side of the ends of the vertical boards, so forming a long trough, whose bottom is the ends of the vertical hanging boards, and whose sides are notched at each board breadth, and at each notch a little stream trickles out and over the length of the board hanging below. Below the lower tier of boards is a free fall through the air of a few feet. The only objection to all such systems is the necessity of pumping up the water to be cooled, but the power absorbed is a very small fraction of the gain by condensing. Cooling is chiefly due to the carrying off of heat by the vapourised water in the latent form, though there is also the full effect of radiant loss, and some amount of heat is absorbed by the air sweeping over the exposed water films. The chief cooling action, however, is that by vapourisation, and the effect is good in the hottest and driest weather, and worst, of course, in a damp atmosphere.

For years travellers will have been familiar with the pile of brushwood in the middle of a pond near the railway at Laisterdyke in Yorkshire. The condensing water is poured over and distributed by this heap of brushwood, and it forms one of the earliest examples of cooling by multiple surfaces of which we have any knowledge.

THE CATHODE RAYS UNDER THE INFLUENCE OF STRONG MAGNETIC FORCES.

Herr Kr. Birkeland has published in the Norwegian *Elektroteknisk Tidsskrift*, of April 20th, a contribution on the above subject, which, we think, will be found of considerable interest in these days of X rays. We accordingly give, as shortly as possible, in what follows, an account of Birkeland's investigations.

Fig. 4 illustrates an experiment which shows how *the cathode rays are developed with special facility along the lines of force in a strong magnetic field, and can only with great difficulty be produced in other directions.*

The negative pole consists of an aluminium cross, which is fixed in the centre of the exhausted sphere. The degree of exhaustion of the tube is denoted by the length of the parallel spark in air between spheres 1 cm. in diameter. During the experiments, the parallel spark length varied between 5 and 50 mm. In direct proximity to the tube a powerful straight electro-magnet was mounted, its axis being perpendicular to the aluminium cross, and passing through its centre.

If discharges are now sent through the tube so that the cross forms the cathode, and without the magnet being energised, the vacuum sphere phosphoresces with more or less intensity and regularity according as the parallel spark is longer or shorter.

When, however, the electro-magnet is energised by a current of about 20 amperes, the luminous phenomena in the bulb assume the sharply defined and regular form shown in fig. 4. Proceeding from the cathode, but separated from it by a dark space, a strong luminous band, having a bright blue colour with a violet tinge, radiates towards the magnet. This luminous band forms at its intersection with the glass wall of the bulb, a lilac coloured nearly white cross, of a reduced size, if the parallel spark is comparatively short; when the parallel spark is long, the cross is of an intensely yellow colour.

The luminous cross is always yellow when the electric discharge passes also through another discharge tube arranged in series, and having a long parallel spark length.

Fig. 2.

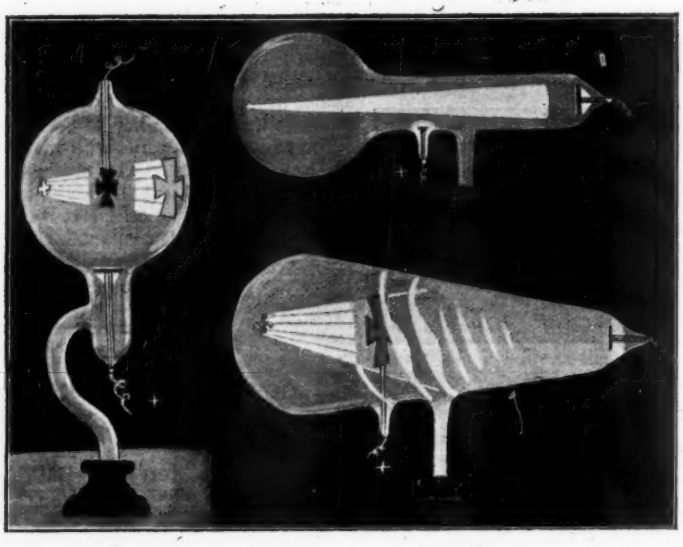


Fig. 1. Fig. 3a.

Further, it is an interesting, though not altogether unexpected fact, that if the intense cross has remained for some time on a particular part of the tube, the glass there loses the power of phosphorescing under the cathode discharge, so for weeks after, a sharp, dark cross can be seen at the same place when the glass wall is subjected to the ordinary cathode discharge without using the electro-magnet.

Divergent rays are also projected from the other side of the cathode, away from the electro-magnet. These rays are weaker, and are separated from the cathode by a larger dark space; they are blue violet in colour, and are in line with the convergent rays.

This new luminous band throws on the glass a yellow, luminous cross, which, however, has not sharp outlines, and stands upon a background of fainter twisted ornaments in yellow. It ought here to be stated that both crosses—the reduced and the enlarged—are turned through a small angle (about 10°) in the same direction, that is, in the direction of the hands of a watch, if we are looking in the direction of the lines of force.

If the discharge bulb is displaced or turned round a little relatively to the magnet, the two luminous crosses are displaced, so as always to lie on the nearest and furthest parts of the bulb.

In connection with the phenomenon just mentioned, an experiment may be carried out which shows how the magnetic forces are capable of neutralising the property possessed by a concave cathode of converging the cathode rays to a focus. If a Crookes tube with a concave cathode is placed in front of the electro-magnet, with the concavity turned away from the pole of the magnet, the rays will be projected

almost parallel from the cathode, and form a large yellow phosphorescent spot on the opposite wall of the tube. In the middle of this spot there is a sharp shadow of the platinum-iridium plate, on which the rays are focussed in the absence of the magnet.

Fig. 5 illustrates an experiment which shows how *the cathode rays can be converged to a point by a magnet*, the axis of the magnet being perpendicular to the plane of the magnet, and passing through its centre. Cathode rays can be converged to a focus by a magnet quite as effectively as rays of light can be brought to a focus by a lens. The distance between the magnet and the tube can easily be so arranged that the rays can be brought to a focus the size of a needle point on the inner side of the glass wall of the bulb. The action of such a point is very intense. If it is allowed to travel over the surface of the glass, it leaves the mark of its track by splitting off glass particles from the wall; so that,

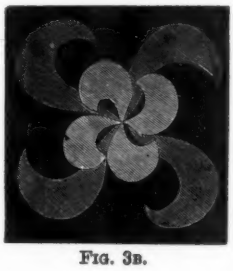


Fig. 3b.

for instance, writing may be etched on the glass by this means. If the point is allowed to remain stationary, the glass will soon be melted at this place, and a small hole bored.

It happens occasionally that the tube bursts before the hole is melted through; in two or three cases, a hole of about 1 mm. diameter has been produced. One was perforated in 6 seconds through millimetre thick glass; the other, in thinner glass, in two seconds.

When a cylindrical discharge tube is placed in a uniform magnetic field between the poles of a large horse-shoe magnet, there is no convergence of the cathode rays to a focus; it is, therefore, probable that this effect in the experiments described above is due to the convergence of the magnetic lines of force in the field at the end of a straight magnet.

When the distance between the discharge tube and the straight magnet is slowly changed within suitable limits, a novel and remarkable phenomenon will soon be observed. This will be most easily described by citing the data of a particular experiment which was made with an imperfectly exhausted pear-shaped Röntgen tube having a parallel spark length of 1·5 mm.

If such a tube be placed with its axis in line with the axis of the magnet and moved towards the magnet, the phosphorescent spot produced on the wall of the tube, which is of normal size at a distance of 15 cm. from the magnet, becomes gradually smaller, till at a distance of 5 cm. it is reduced to a glowing point. At the same time the cathode rays has an intense blue cone of light passing through the rarefied air in the tube. While the first phosphorescent spot is thus disappearing, a new spot, smaller and fainter than the first, is discovered. This second spot, in turn, is also reduced to a glowing point at a distance of 2 cm. from the magnet. By this time a third spot has been discovered, smaller and fainter than the second, and this also becomes ever smaller as the distance between the tube and the magnet is diminished. When the tube comes in contact with the end of the magnet, the spot is very small, but has not yet been reduced to a point.

The dark space, next to the cathode, also undergoes certain changes while the tube approaches the magnet. From 5·8 cm. to 2·6 cm. it contracts; at certain distances, for example, 5 cm. and 2·1 cm., the change takes place by jumps.

All that has hitherto been described takes place the same with the north pole as with the south pole of the magnet.

These results appear to show that a cathode emits diverse groups of different rays, related to each other somewhat as the harmonics of a vibrating string. This point will be further illustrated by the following experiment:—

Fig. 6*a* represents one of the well-known forms of Crookes tubes, with a Maltese cross fixed inside it, as shown. It is placed as in the former experiments, coaxial with the magnet. The original parallel spark length of the tube, before the experiments to which Figs. 6*a* and *b*, 7*a*, *b*, *c*, *d*, and *e* refer, was about 7—5 mm.

It is assumed that the excited tube is being moved towards the magnet, which is energised by a current of about 20 amperes. At a minimum distance of 20 cm. between the tube and the magnet the ordinary shadow cross, fig. 7*a*, is seen on the side of the glass tube opposite the cathode, but turned through a small angle. As the tube continues to approach the magnet, the phosphorescent spot, and also the shadow cross, contract at first slowly, and then more quickly, while the cross at the same time turns round and becomes fainter. When the distance is reduced to 4 cm. the figure of the cross disappears in a glowing point at the moment when the whole has been turned through an angle of 180°. This angle does not appear to be necessarily dependent on the magnetic force, but on the distance between the Maltese cross and the glass wall which receives the shadow. Before the first spot disappears a new phosphorescent (7*c*) spot appears in the meantime, but smaller and fainter than the first. In this spot a new twisted shadow cross soon makes its appearance.

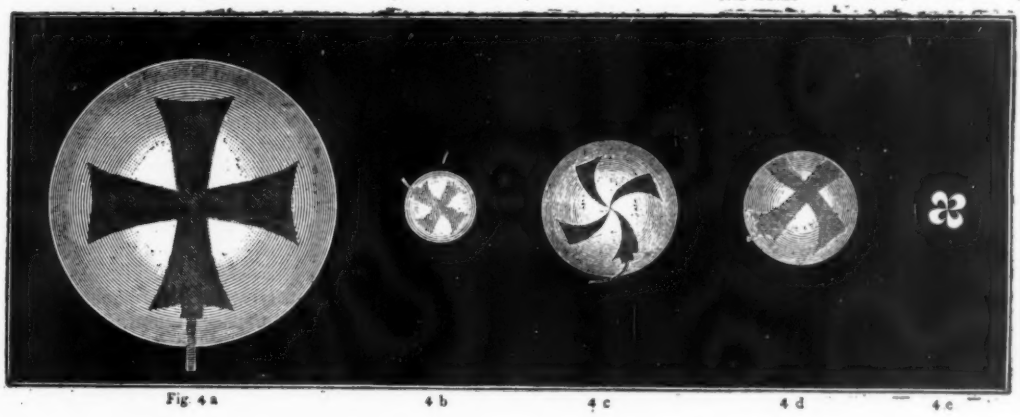


Fig 4a 4b 4c 4d 4e

The new figure now changes its appearance; the cross expands and becomes indistinct, while the luminous spot, on the contrary, contracts (figs. 7*d*, 7*e*). After turning through an angle, which is smaller than in the former case, the luminous spot in this case also contracts into a glowing point. Before, however, this happens, at a distance of 1·7 cm. from the magnet, there appears a third luminous spot with a rapidly expanding twisted shadow cross, and this goes through the same series of changes as the two foregoing. The rosette (fig. 6*b*) illustrates the relation between the second and third figures at a certain epoch. The figures shown are those which appear in front of a south pole; in

front of a north pole, the distortion would be in the opposite direction. As many as five successive phosphorescent spots have been obtained in some experiments. When the motion of the tube is towards the magnet, the turning of all the figures is clockwise when looking along the magnetic lines of force; when the motion is from the magnet, the turning of the figures is, of course, in the opposite direction.

If the vacuum of the Crookes tube is low (say, having a parallel spark length less than 1·5 mm.), along with the phenomena already described, a small lilac-coloured cross appears on the end of the tube. This is due to the fact that the resistance of the tube is so low that both the make and break of the coil is able to send a discharge through it, and consequently makes the cross alternately an anode and a cathode. This lilac cross disappears when the tube has been working for some time under the influence of the magnet, owing to the increase of resistance. It is worthy of remark that the cathod beam, at the moment when this change takes place, and especially if the magnet at the same time undergoes slight variations of intensity, has a remarkable resemblance to a certain species of the aurora borealis.

The intrusive lilac cross may also be avoided by connecting up a Röntgen tube in series with the Crookes tube. With this arrangement, the different "cathode harmonics" can be brought out with wonderful clearness and beauty.

There are certain curious light effects on the sides of the tube in the neighbourhood of the cathode, which it would take too long to describe in detail. The most remarkable consist of a series of yellow phosphorescent bands, which appear sometimes as more or less complete circles, sometimes as connected spirals (see fig. 6*a*).

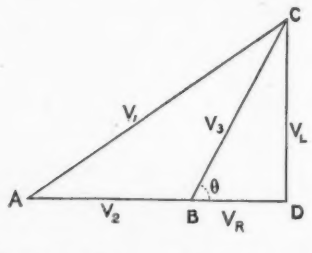
(*To be continued.*)

THE THREE-VOLTMETER METHOD OF MEASURING POWER.

[By BERNARD P. SCATTERGOOD, M.A., Oxon.

The following is a simple geometrical proof of the "three-voltmeter" method of measuring the power absorbed by an inductive circuit in which an alternating current is passing, which I do not remember to have seen in print before.

Let R be the inductive resistance, W the power in watts absorbed by R when a current, I, is passing, r the non-inductive resistance of known value, in series with R. Also, let V_1 be the voltage across the combined resistance $R + r$, V_2 that across the non-inductive resistance r, and V_3 that



across the inductive resistance R in which the power is to be measured. The volts are square-root-of-mean-square values as read on an electrostatic voltmeter, and neither the current, I, nor the resistance, R, need be known.

The three voltages, V_1, V_2, V_3, can be represented graphically by the three sides of an obtuse-angled triangle, A B C, of which the longest side, A C, represents V_1 the electromotive force impressed at the terminals of $r + R$, and the other two sides, A B and B C, represent the electromotive forces V_2 and V_3, the components of V_1. As the resistance r is non-inductive, the current in the circuit is in phase with the pressure V_2 across the terminals of r, and thus the line A B represents in direction, and also, to a proper scale, in magnitude, the current I, as well as the pressure V_2. The lines A B and B C, representing the components of V_1, are inclined to each other at an angle θ, which is the angle of lag of current behind impressed electromotive force in the inductive part of the circuit.

Producing, as in the figure, A B through B, and drawing C D at right angles to this line, and meeting it at the point D, it is obvious that C D, being drawn in quadrature with the line of current A B, must represent in magnitude and direction the back electromotive force of self-induction; and therefore B D, which is the resultant of the impressed electromotive force B C (or V_3) and C D (which we may briefly call V_L) represents in magnitude and direction the effective electromotive force sending current through the inductive resistance, R. Call this effective electromotive force, V_R. Then, plainly,

$$W = V_R I,$$

but

$$I = \frac{V_2}{r}$$

(since the resistance, r, has negligible self-induction).

Hence

$$W = \frac{V_2 V_R}{r} \qquad (1)$$

Also from the figure, by Euclid I., 47,

$$V_1^2 = (V_2 + V_R)^2 + V_L^2,$$
$$= V_2^2 + 2 V_2 V_R + V_R^2 + V_L^2,$$

but $V_R^2 + V_L^2 = V_3^2$ (also by Euclid I., 47).

Therefore $V_1^2 = V_2^2 + V_3^2 + 2 V_2 V_R$,

and

$$V_2 V_R = \frac{V_1^2 - V_2^2 - V_3^2}{2}.$$

Hence, substituting this value of $V_2 V_R$ in equation (1), we arrive at once at the well known formula

$$W = \frac{I}{2r}(V_1^2 - V_2^2 - V_3^2).$$

COAL CONSUMPTION IN CENTRAL STATIONS.

The following is the report of Committee on Data, presented at the N. E. L. A. Convention, New York:—Your Committee is able to present a tabulated statement of watt-hours produced per pound of coal from 82 central stations using coal as fuel, and from one using crude oil, and are able to show the class of equipment from all, boiler tests from 32, and engine efficiency from eight. So far, the work has been carried forward on the lines of the previous reports by this Committee. Economies are given from a number of the largest electric stations in the country, five of them having an output of over 10,000,000 watt-hours per day, and 45 having an output of 1 to 10 million watt-hours per day. Four of the large stations represent a production of 94,270 kilowatt-hours, and a consumption of 524,667 lbs. of coal, or 179 watt-hours per lb. of coal. The aggregate output of these 49 large stations reaches the production of 212,617 kilowatt-hours in one day, at an expense of 1,316,703 lbs. of coal, or an average of 161 watt-hours per pound of coal. The aggregate output of 32 smaller stations, those producing less than 1 million watt-hours per day, represents a production of 11,973 kilowatt-hours with an expenditure of 194,274 lbs. of coal, or 62 watt-hours per pound of coal. The aggregate electrical output of entire report, several stations having reported for a long period, in one case (Report 6) for one year, represents the generation of 4,618,976 kilowatt-hours at an expense of 28,274,536 lbs. of coal, or an average of 164 watt-hours per pound of coal. The average efficiency of the 81 reports using coal as fuel is 108 watt-hours per pound of coal; one report giving the production from crude oil shows 1,717 watt-hours per gallon of oil.

The load lines shown in the charts have been constructed from 30-minute readings from meters, or estimated from voltage and amperes. The Committee realise that in the case of alternating currents the product of amperes times volts may not give the absolute watts, but this method has been considered sufficiently accurate for this work, and has been used in a few instances. The minor points called for in the information blank sent out by the Committee relative to evapora-

TABULATED REPORT FROM ELECTRIC LIGHT STATIONS; Showing Watts per lb. of Fuel, Equipment, Efficiency, &c.

No. of report.	Hours in run.	Watt hours. One day.	Coal used. One day. Lbs.	Watt hours per lb. coal.	Fuel—Kind and Grade.	Equipment. (See foot notes.)			Boiler test evaporation.			Engine test. Water per hour per I.H.P.	No. of report.
						Engines.	Boilers.	Dynamos.	Per lb. coal.	Per lb. combustible. Actual	Per lb. combustible. From and at 212°.		
1	24	3,207,392	11,600	237	Bit. Lump	D	C	V	6·2	6 87	7·12	...	1
2	24	2,397,712	11,251	213	Bit. Lump [Screenings	D	C	V	5.7	6·45	6·69	...	2
3	24	26,402,256	124,383	212	½ Ea. Soft Coal and Hard	A	A	A	7 38	8·81	10 22	18·	3
4	24	5,053,166	28,050	180	½ Anth. ½ Pea and Dust	B	1A, 5C	B	8 91	...	...	36 9	4
5	24	1,818,780	10,200	178	·4 Coke ·6 Coal	CD	C	V	5·04	5 75	6·41	27·6	5
6	24	11,488,569	65,884	174[4]	Bit. Run of Mine ...	BDz	C	V	...	...	...	...	6
7	24	1,212,900	7,105	171	" " " ...	B	C	V	...	...	...	...	7
8	24	825,000	5,022	164	Bit. and Hard Screenings	Ex	C	V	10 35	11·48	...	...	8
9	24	4,270,077	26,600	161	½ Anth. ½ Dust and Pea	B	1A, 5C	V	9 17	...	...	42·2	9
10	14	1,718,000	11,400	151	Bit. Va.	BC	C	V	...	...	...	...	10
11	15½	8,600	5 500	151	" "	CD	A	Alt.	...	...	...	...	11
12	24	2,156,000	14,493	149	Buckwheat	3C, 1E	C	Alt.	8 90	10 34	11 23	...	12
13	14	1,625,000	11,440	142	Bit.	BC	C	V	...	...	...	...	13
14	16½	711,720	5,100	140	Bit. Slack	D	C	V	...	...	...	...	14
15	16⅔	727,720	5,200	140	Bit.	D	C	V	...	...	...	...	15
16	14	1,624,000	11,840	137	Bit. Run of Mine ...	BC	C	V	...	...	...	...	16
17	14	2,734,976	19,900	137	Slack	Dx	B	V	8·25	8 9	9·43	...	17
18	14	2,590,705	19,050	136	Slack	Dx	B	V	7 92	9·35	9·9	...	18
19	14	1,526,000	11,200	136	Bit. Run of Mine ...	BC	C	V	...	...	...	...	19
20	14	1,560,000	11,600	134	" " " ...	BC	C	V	...	...	...	...	20
21	14	2,722,463	20,650	134	Slack	Dx	B	V	7 08	8·8	9·39	...	21
22	24	16,140,010	121,400	133	Slack and Bit.	B	C	V	...	...	...	...	22
23	16	1,528,100	11,595	131	Bit. Lump	D	C	V	...	...	...	...	23
24	15½	695,720	5,300	131	Bit.	D	C	V	...	...	...	...	24
25	16	1,549,100	11,860	131	Bit. Run of Mine ...	B	C	V	7·7	8·3	...	...	25
26	24	5,401,900	41,924	129	Semi-Bit.	EDx	BC	...	9 5	12·2	...	30	26
27	14	1,399,000	11,200	126	Bit.	BC	C	V	...	...	...	...	27
28	16	1,568,600	12,000	131	Bit. Lump	B	C	V	7.7	8·3	...	...	28
29	13	2,103,800	16,800	125	Anth. Buckwheat ...	Cx	C	C	8 84	8 26	8 73	26	29
30	24	2,683,008	21 571	124	Bit. Nut and Slack ...	Ex	AC	Bi.F.	...	...	...	...	30
31	17½	3,396,619	27,414	124	... ...	...	...	...	9 03	9·6	...	...	31
32	24	1,763,795	15,625	113	¼ Ea. Bit. and Anth. ...	EDx	C	B	8·13	10 57	11·02	...	32
33	24	6,794,304	62,504	109	·6 Anth. ·4 Bit. ...	Ex	6C, 5A	BE	...	...	...	...	33
34	24	1,193,876	10,475	106	Anth. Buckwheat ...	4C, 1E	C	C	...	...	...	...	34
35	24	1,074,436	10,250	105	" "	4C, 1E	C	C	...	...	...	...	35
36	...	160,049,985[5]	1,533,000	104	Bit. Screenings	BC	AB	...	...	...	...	...	36
37	12½	2,202,363	22,050	100	Lignite, Run of Mine ...	BDx	AC	Alt.	4·8	5·2	...	...	37
38	...	288,440	3,041	95	Bit. " " ...	Ex	C	C	...	...	...	...	38
39	9½	454,058	4,831	94	Slack	D	A	V	...	...	...	...	39
40	13	903,720	9,812	92	Bellwood Bit.	BDx	A	...	5·1	5·6	5 93	...	40
41	...	268,800	2,896	92	" "	Ex	C	C	...	...	...	...	41
42	24	1,444,931	20,800	69	Slack	Ex	BC	BC	6·33	...	...	...	42
43	6½	93,541	1,365	68	Buckwheat, Anth. ...	E	C	C	...	...	...	...	43
44	8	230,187	3,600	64	... ...	Ex	C	B	...	...	...	...	44
45	14¾	310,928	5,000	62	Bit.	Ex	C	V	...	...	...	...	45
46	15	254,745	4,520	56	Bit.	Dx	C	C	...	...	...	...	46
47	7½	186,412	3,810	49	Slack	Ex	C	B	...	...	...	...	47
48	24	66,285,375[5]	1,160,500	57	Bit.	1D, 2Ex	A	C	...	...	...	...	48
49	14	156,800	2,8 0	56	Bit. Run of Mine ...	Ex	C	C	...	...	...	...	49
50	7½	214,485	3,900	56	Bit.	Ex	C	B	...	...	...	...	50
51	7½	204,435	5,600	57	Bit.	Ex	C	B	...	...	...	...	51
52	10	6,453,491[5]	116,000	56	Bit. and Slack	Cx	C	Alt.	...	...	...	...	52
53	7½	217,228	4,000	54	Bit	Ex	C	B	...	...	...	...	53
54	7	221,250	4,200	53	Bit.	Ex	C	B	...	...	...	...	54
55	7½	186,412	3,810	49	Slack	Ex	C	B	...	...	...	...	55
56	7	208,535	3,900	53	Bit.	Ex	C	B	...	...	...	...	56
57	6	161,458	3,150	51	Bit.	Ex	C	B	...	...	...	...	57
58	7½	174,928	3,720	47	Bit.	Ex	C	B	...	...	...	...	58
59	15	203,555	6,200	33	Anth. Buckwheat ...	E	C	V	...	...	...	...	59
60	14	762,825	20,700	37	Bit. Slack	Exy	C	V	5·44	...	...	...	60
61	15½	806,880	19,300	42	" "	Exy	C	V	5·78	...	...	...	61
62	18	1,294,703	31,040	42	" "	Ex	C	V	4·23	...	...	...	62
63	16½	866,235	20,500	42	" "	Exy	C	V	5·75	...	...	...	63
64	14	1,454,656	31,739	46	Bit. No. 2 Nut	Cx	B	V	5·48	6·5	6·85	...	64
65	14½	1,881,102	31,992	59	" "	Cx	B	V	5·8	7·1	7·48	...	65
66	24	194,472	3,300	65	Wilmington Lump ...	(1E, 7C) x	C	C	...	...	...	...	66
67	8	444,133	6,101	73	Bit. Slack	Ex	C	V	4·66	...	...	...	67
68	14	1,201,483	15,386	78	Bit.	C	C	Alt.	...	...	...	...	68
69	10	506,697	6,296	80	Bit. Slack	Ex	C	V	5 59	...	...	...	69
70	24	5,982,000	71,000	84	Bit. Screenings... ...	(6D 1E 5Dz) x	A	V	...	...	...	...	70
71	14½	1,243,441	14,224	87	Bit.	C	C	Alt.	...	...	...	...	71
72	14	477,425	5,400	88	Semi-Bit.	Ex	C	Alt.	9·68	10·7	11·13	37	72
73	24	2,879,000	31,200	92	Bit. Screenings... ...	Dxz	A	A	...	...	...	...	73
74	13½	1,217,000	12,895	94	Anth.	Ex	C	V	...	...	...	...	74
75	24	1,960,973	17,600	111	Bit.	Ex	C	V	...	...	...	...	75
76	24	3,366,065	20,300	166	½ Ea. Anth. Bit.	B	A	Alt.	6·82	7 89	9·20	...	76
77	24	3,373,305	20,300	166	" "	B	A	Alt.	6·2	7·14	8·33	...	77
78	24	3,398,595	20,300	167	" "	B	A	Alt.	6·6	7 56	8 82	...	78
79	24	40,230,300	213,000	189	Bit. Screenings... ...	A	A	A	...	...	...	15½	79
80	24	14,941,089	8,700gals	1,717[6]	Crude Petroleum ...	D	2B, 1C	B	...	...	...	...	80
81	24	3,455,988	19,100	181	Semi-Bit.	(A.D.E)xy	C	V	10 5	...	...	...	81
82	24	5,761,915	40,800	141	3 Slack 1 Nut	1D, 2B	B	V	...	...	...	...	82

NOTES.—4, Average from one year's record.
5, Total for one month.
6, Per gallon of oil.

Equipment Letters denote classes as follows:—
A. Engines, triple expansion condensing. Boilers, horizontal water tube. Dynamos, multipolar on engine shaft.
B. Engines, Corliss compound condensing. Boilers, vertical water tube. Dynamos, bipolar, belted from jack shaft.
C. Engines, simple Corliss, or slow speed condensing. Boilers, horizontal tubular. Dynamos, continuous current.
D. Engines, high speed compound condensing, belted direct to dynamo.
E. Engines, simple high speed condensing, belted direct to dynamo.
x. Any of the above non-condensing.
y. Belted to dynamos.
z. Dynamo on engine shaft.

tion per pound of coal, water used in the engines, calorimeter tests, &c., have not received very general attention, although simple directions were given for this work. The 31 stations reporting the water evaporated per pound of coal show a wide range of boiler efficiency not to be accounted for by the difference in quality of fuel. Report No. 81 evaporates 10·5 lbs. of water per pound of semi-bituminous coal, comparing favourably with report No. 8, each using horizontal tubular boilers; while report 67 evaporates only 4·66 lbs. of water per pound of bituminous coal with the same style of boilers. The average evaporation per pound of coal from all stations giving reports being 7·09. In engine efficiency eight stations report the water consumption per indicated horse-power. The triple expansions lead in economy, report 80 showing a consumption of 15½ lbs., and report 3 showing 18 lbs. of water per indicated horse-power; these comparing reasonably with report 29, where an indicated horse-power is produced by non-condensing engines with 26 lbs. of water. Report No. 22 in the Table of Economies submitted at the last convention, showing [a] [production] of 262 watts per pound of coal, and having the highest economy in the stations mentioned in that report, is from the same station as report No. 3 in the present table, and which in point of economy stands third on the list, the economy being 212 watts per pound of coal, a showing somewhat inferior to the previous report. The station is reported in a general way as running at greater economy than when the previous report was made. The efficiency figures, however, would seem to contradict this statement and to verify the statement in the present report. In the previous report, 9·37 lbs. of water were evaporated per pound of combustible, and 17 lbs. of water consumed in the engines per horse-power. The present report brings the evaporation per pound of combustible down to 8·81 lbs. of water, and the steam consumption in the engines is raised to 18 lbs., which would account for the lower efficiency stated in the present report.

Attention is called to the reports from plants running with non-condensing engines, in which report 26 (see load line) is able to show 129 watt-hours per pound of coal; report 32 (see load line), 113 watt-hours; report 33, 109 watt-hours; report 37 (see load line), 100 watt-hours; and report, 38, 95 watt-hours. While Nos. 39 (see load line), 43, 59 (see load line), 68 and 71, running condensing produce respectively only 94, 68, 33, 78 and 87 watt-hours; this showing and other features in the report proving conclusively that it is as much a question of management and manipulation as of the type of machinery used.

In conclusion, we are led to repeat a former statement by this committee that the economy secured in generating power for electrical work does not compare favourably with the production of power for other purposes, and that this is also true after taking into consideration the variation in load due to electrical work. Referring to a recent statement of the economy of the Chestnut Hill pumping station, at Boston, it was found that in actual water lifted a horse-power was produced by the consumption of 1·34 lbs. of coal; allowing that the efficiency of pumps compares favourably with efficiency of the generators, and making no allowance for variation in load, 1 lb. of anthracite coal used with the same economy in electrical work should produce 557 watt-hours. Our load line charts show a fair average of the variation in electrical work, line 3, chart 1, dropping from 1,800 kilowatts at 6 p.m. to 250 kilowatts at midnight; yet the changes seem, as generally true in electric lighting, to be fairly uniform, and a station planned with the proper units for the work should operate the much larger percentage of its generating appliances of a fair basis of economy, bringing the record in this work much nearer the standard of efficiency in other lines. We advise more careful records, more frequent tests of all apparatus, and a steady application of principles of economy until this record can be made to show more favourable comparison.

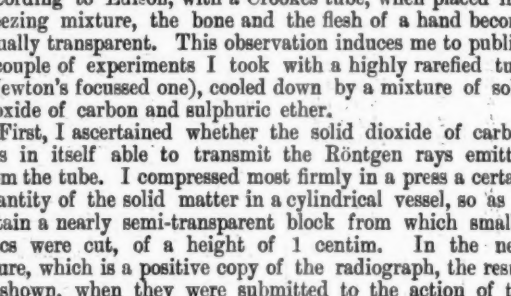
Erratum.—In the article commencing on page 752, "The Cathode Rays, &c.," the figures in the text and the illustrations themselves bear different numbers, but fig. 4 in text is fig. 1 in the illustrations, fig. 5 fig. 2, fig. 6*a* fig. 3*a*, and so on.

RÖNTGEN RAYS AT LOW TEMPERATURES.

By Dr. L. BLEEKRODE.

In the issue of this journal of May 8th, mention is made that according to Edison, with a Crookes tube, when placed in a freezing mixture, the bone and the flesh of a hand become equally transparent. This observation induces me to publish a couple of experiments I took with a highly rarefied tube (Newton's focussed one), cooled down by a mixture of solid dioxide of carbon and sulphuric ether.

First, I ascertained whether the solid dioxide of carbon was in itself able to transmit the Röntgen rays emitted from the tube. I compressed most firmly in a press a certain quantity of the solid matter in a cylindrical vessel, so as to obtain a nearly semi-transparent block from which smaller discs were cut, of a height of 1 centim. In the next figure, which is a positive copy of the radiograph, the result is shown, when they were submitted to the action of the tube. The sensitive plate was laid between two layers of black paper: on the upper one was placed in *a*, a thin plate of aluminium, covered partly by a disc of brass (½ millim. thick) in c, the carbon dioxide cylinder was applied, having



a, Aluminium plate with brass disc; *b*, Cylinder of dioxide of carbon with aluminium plate included (metal hardly visible); *c*, the same, with brass disc included.

inserted at its base (turned to the plate) also a little piece of thin aluminium, and likewise in c a second cylinder of the dioxide is visible, with a brass disc included at the base. It will be distinctly remarked that in *a* the aluminium showed, as is well known, its almost perfectly transparency, as the dotted line serves to indicate the place occupied by it, whilst it differs most from the brass in this respect. The aluminium impression was, of course, almost invisible on the negative plate. The carbon dioxide, a substance at a temperature of — 79° C. in free air, transmitting evidently the Röntgen rays to a certain amount, much better than brass, as may be judged comparatively in c, though it was at least twenty times as thick. Even at c the aluminium plate is visible, when inspected carefully, showing its transparency to have lessened, when embodied in the very cold mass, and this may be accounted for by its density having much increased at the very low temperature.

Having thus ascertained that carbon dioxide, when solid, can transmit the Röntgen rays to a certain extent, I laid down the Crookes tube on a layer of this substance, to which some sulphuric ether was added, to ensure close contact, and the cathodic rays could proceed first horizontally, and afterwards were reflected to the cooled surface, in the known way. At first, on admitting the electrical discharge from the coil (14 centim. spark), the glow was more intense than when working at common temperature; afterwards it subsided somewhat, perhaps by the increased resistance, as remaining vapours of mercury were condensed. But at different spots of the glass wall, and very near to the cold layer, brilliant phosphorescent specks were visible, remaining so for some minutes, even when the action of the coil was interrupted. They did not appear on ordinary circumstances, and seem to indicate, in accordance with Prof. Dewar's researches on phosphorescence at very low temperatures, that this property of glass is also here enhanced. As to the photochemical effect, it resulted that the rays emanating from a glass surface at —79° were equally effective as at the ordinary temperature; a radiograph of the finger showed equally well flesh and bone as commonly taken and required the same time; also was this the case with

metallic objects. Likewise, with the electroscope, there was no evidence that the effect was lessened, as it required the same number of seconds to be discharged by the influence of the rays, whether the tube was cooled at $-79°$ or not. Perhaps this negative result may prove of interest to the opinion that the glass wall is the centre of the emission of the Röntgen rays when excited by the discharge from the cathode.

The Hague, *June*, 1896.

THE EVOLUTION OF MODERN THEORIES OF ELECTROLYSIS.

(Concluded from page 714.)

Applying the idea to electrolytes, and bearing in mind Faraday's laws, it is conceivable that the electric force influences the direction of the ions at such instants as they are changing from one molecule to another, at which instants they may be regarded as being potentially free from combination, and therefore susceptible to the directing force of the current. Only bodies thus capable of momentary dissociation into their ionic constituents will be capable of electrolysis. The result of this momentary pull on the ions, while they are changing partners, is to give them a directing tendency towards the electrodes. At the electrodes, the electric pull is strong enough to split the strongest molecule, and attract to itself one ion, while the other finds new partners to combine with on its path toward the other electrode. Each ion, therefore, brings to, or neutralises at the electrode, a definite quantity of electricity, and the current is thus conveyed by a species of convection through the electrolyte, while the attracting electric potential remains less than the force with which the atoms tend toward each other in the molecule, there cannot be complete decomposition of the electrolyte; there can only be a gathering of ions on the electrodes, which cannot surpass a given ratio to the number of momentarily free ions in the electrolyte. When the acting potential just equals the theoretical voltage necessary for complete decomposition, this ratio becomes unity; that is, as many ions are set free at the electrodes in a given time as are momentarily set free, or as are potentially dissociated in the body of the electrolyte during the same time; and from then on, the ions accumulate without limit in quantitative proportion to the quantity of electric current passing, until the electrolyte is completely decomposed. This, however, would be an extremely slow operation. But suppose the acting potential measurably greater, the ions are then forced apart through the body of the electrolyte, and form a steady procession toward each electrode. In other words, when the attraction of the electrodes is greater than that of the ions for each other, they incontinently take leave of each other, and set up a procession toward each electrode.

The last sentence gives the key to the valuable discoveries of Hittorf. It was well known before his time, that when electrolysing a solution, it gradually becomes impoverished around one electrode and concentrated around the other, if means are taken to prevent diffusion. Hittorf explains the changes of concentration by supposing the ions to migrate through the electrolyte towards the electrodes at a different rate of speed. If they moved with equal velocity, each outside cell would lose an equal number of couples in a given time; if, however, one moved faster than the other, the outside cells would lose a different number of couples, which would change the concentration in the cells.

Hittorf determined migration values for the velocities of the ions in many electrolytes, and found that the quantity of the current passing had no influence on the relative velocities of the ions, but that the concentration of the solution had considerable influence, starting with a concentrated solution. The relative velocities of the two ions changed as the solution was diluted, *until a certain dilution was reached, after which there was no further change in the relative velocities.* This behaviour was found to be characteristic of all electrolytes.

Kohlrausch made the next great advance in our knowledge of the mechanism of electrolysis. He devised extremely accurate apparatus for measuring the conductivity of electrolytes. If we take the conception of Faraday and Clausius that electrolytic conduction is a species of electric convection from one electrode to the other, then the conductivity should depend simply on the number or concentration of the electricity-carrying ions between the electrodes. If the solution be diluted to one-half, there will only be one-half as many ions between two fixed electrodes of given size, and therefore the electric conductivity should be exactly one-half; or the conductivity should be exactly proportional to the number of ions between the electrodes. Expressing it in another way, the conductivity should be inversely as the dilution of the solution. Kohlrausch introduced a new expression, viz., the molecular conductivity, *i.e.*, the electric conductivity divided by the relative number of molecules between the electrodes. He determined that this molecular conductivity *increased* with increasing dilution, until it reached a certain limiting value characteristic of each salt, after which it remained constant.

A discussion of the values for the molecular conductivity of different salts soon revealed very interesting relations. It was easily observed (*e.g.* by Ostwald) that there was an approximately constant difference between the molecular conductivity of similar salts of similar bases. If these differences are constants, it follows that the molecular conductivity of a salt is composed of two factors, one of which depends on one constituent and one on the other, and that the molecular conductivity is merely the sum of the conductivities of the ions. It was not a difficult step then to connect this conductive capacity of the ions with the differing velocities of the ions, or their "migration values."

Now followed, in order of the development of the theory of electrolyses, Arrhenius's work (1882). He viewed the question of the increase of molecular conductivity with increasing dilution up to a certain limit, in a different light from his predecessors. He imagined this peculiar conduct to be due to the fact that, in general, not all the molecules between the electrodes take part in carrying the current, but only a part of them are "active," and another fraction of them "inactive." This distinction of active and inactive molecules is of the greatest importance in the evolution of Arrhenius's ideas. The increase in molecular conductivity with dilution would therefore be due to an increase in the proportion of active molecules, until, when all became *active*, the molecular conductivity reached its maximum, and after that further dilution would have no effect.

Now the idea of *active and inactive mass* was a conception already introduced into chemistry by Guldberg and Waage, and Arrhenius put to the test at once the question whether the proportion of *active molecules*, as determined by the molecular conductivity, had any relation to the *active mass* which measures the facility of a material to take part in chemical reactions. The result of the experiments, confirmed later by others, and in particular by Ostwald, was a complete identification of the two functions. The purely chemical ways of making the measurements, such as those of Thomsen, were not as reliable as could be wished, so Ostwald devised more accurate tests, and most strikingly proved Arrhenius's ideas, the deviation between the chemical and electrical investigations being in every case within the limits of experimental error.

The question at once arose in what respect do the *active* differ from the *inactive* molecules? Arrhenius supposed at first that the *inactive* were polymerised molecules, which, on dilution, became depolymerised, and therefore *active*. The further developments, however, soon caused him to drop this idea, and to advance one of the most startling theories of modern chemistry.

The law, according to which the molecular conductivity increases to a maximum, was carefully studied, for this must also be the law governing chemical avidity. From Kohlrausch's observations, it appeared that the molecular conductivities of the acids must all be approaching the same limiting value, and that at infinite dilution the molecular conductivities, and therefore the relative avidities of the different acids become all alike; in this case, also, the molecules have become active. At lower dilutions the activity of the acids are in direct proportion to the relative number of active molecules, *i.e.*, to their molecular conductivity.

Ostwald showed, further, that the limiting value of the conductivity of bibasic, tribasic, and tetrabasic acids is sensibly only one-half, one-third, and one-fourth that of an

equivalent solution of a unibasic acid. To have the same degree of activity at great dilution, it is therefore necessary to compare *not equivalent, but molecular quantities*, of these acids.

Arrhenius's ideas were further developed under the influence of Van't Hoff's discoveries of the osmotic pressure of solutions, the equation for which is the same as the well-known formula for gases, $p\,v = \text{R}\,\text{T}$. But some solutions investigated by Van't Hoff showed a deviation from the rule. Soon, however, Arrhenius noticed that all the solutions showing the anomalous behaviour were *electrolytes*, and he advanced the idea that in such solutions the salts were already partly separated into their ions, which increase in the number of molecules, would explain the increase in the osmotic pressure, and cause the irregularities in the boiling and freezing points observed in such solutions.

We have thus reached a statement of the modern theory of electrolytic dissociation into ions in solutions. In 1887 Arrhenius made a memorable communication on this subject to the Stockholm Academy of Science, in which he connected his new ideas with his older discoveries in the following words:—

"The difference between *active* and *inactive* molecules consists in that the first are split into their *ions;* the latter not.

"Only the free ions take part in the conducting of electricity and in chemical reactions; thence results the proportionality between the properties of electric conductivity and chemical activity.

"The ions behave in the solution as independent molecules; thence result the deviations which electrolytes show from Van't Hoff's gas law for osmotic pressure."

The next step in the evolution of this theory, namely, the proof of these propositions was to be found in determining experimentally the parallelisms of these deviations. Mathematical analyses were undertaken, and Arrhenius also made some laborious experimental investigations, with the result that the truth of the relations affirmed, or, rather, predicted, was proved decisively; and, later, more exact determinations confirmed it even more strikingly.

If the theory of electrolytic dissociation be really a law of nature, then the following conclusions must be true:—

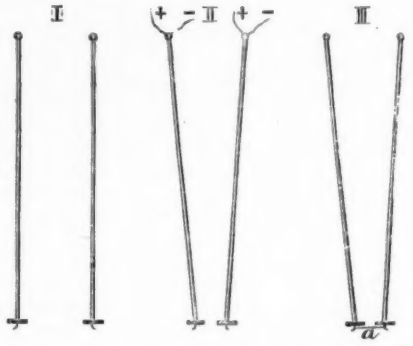
1. Since the ions are independent of each other, it does not matter with what element they were formerly united before dissociation; and the properties of the salt solution at the limiting dilution must become the binary sum of the properties of the two ions; all its properties must be strictly additive.

[Kohlrausch proved that the molecular conductivity at the limiting value is an additive quantity, and Richards has observed that the heat of formation of the salts in dilute solution is also a strictly additive quantity.]

2. Only the *ions* show chemical activity. Therefore, as soon as one element exists in solution, *not as a simple ion*, but as part of a complex ion, it shows no longer the characteristic reaction of that element.

In his paper, Dr. Richards referred to the "struggles of Arrhenius, Van't Hoff, Ostwald, Planck, Nernst, and others, to convince the doubting world of science" of the truth of the new theory of electrolytic dissociation. Ostwald and Planck had proved that the law regulating the increase in molecular conductivity on dilution is the identical law governing the *dissociation of a gas into two constituents*, which is derived from mechanical considerations and confirmed by experiment. Budde and Kohlrausch had calculated the absolute velocities of the ions through the electrolyte, from which could be deduced the mechanical force necessary to give the ions this velocity. Nernst had pointed out the relation between this force and the diffusion constant, and that the velocity of diffusion and that of migration of the ions are conditioned by the same kind of internal friction. Whence his theory of diffusion which has thrown so much light on the working of the galvanic cell.

Dr. Richards then concludes his paper with an explanation from his own point of view of a conception of the theory which has rendered it more acceptable to his mind, and quieted some persistent doubts as to the possibility of its truth. Imagine two electro-magnets, as in the following figure, hanging by their conducting wires, 1 foot apart, with their unlike poles, when magnetised, pointing towards each other, as in I. Pass an electric current through them, and the magnetic pull will bring them, let us say, to within 3 inches, as in II. Interrupt the current, and the apparatus is ready to illustrate the conception. Bring the magnets to within 3 inches of each other, and hold them there by placing an elastic band around them, as in III. This physical band represents the force of chemical affinity holding two atoms together in a molecule. Now, at a given instant, *throw off* the rubber band, and *throw on* the electric current. If these operations could be performed instantaneously and exactly synchronously, the magnets would remain stationary. The physical bond has disappeared. Yet the magnets remain in exactly the same spot as before, held together by the invisible magnetic pull. The disappearance of the physical bond may be regarded as representing the disappearance of the force of chemical affinity holding the atoms together—in



other words, what we call the dissociation of the molecule. The atoms are still really united by as great a force after the dissociation as they were before, but it is now electrical force which binds them; our chemical energy has been *replaced* by electrical energy; it is a case of conversion of energy. And, further, *since the atoms are no longer held together by the force of chemical affinity*, they will be free to act as if *chemically independent* of each other, *i.e.*, as independent atoms or molecules. This will explain the fact of increase of gas pressure, molecular conductivity, and all those properties of solutions which require for their explanation the conception of *chemically independent atoms* present in the solution.

When the atoms are thus held together by *electrical* instead of chemical energy, they are then susceptible of being ultimately separated by a counter *electric* force, and molecules which do not thus dissociate, but are still held together by chemical energy, cannot be disrupted by the current, and are consequently not electrolytes. The law connecting chemical composition with this tendency to "*dissociate*" has not yet been discovered; but when it is brought to light, as it doubtless will be, we shall gain a clearer insight into the ultimate nature of chemical combination than has ever before been vouchsafed to the enquiring mind of man.

THE RÖNTGEN RAYS.

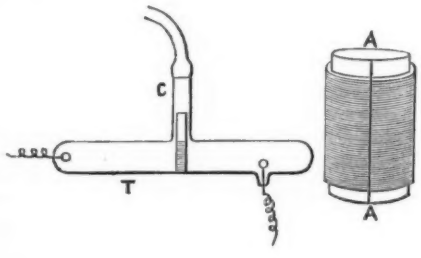
We have already described* the experiments of De Metz on the photographic action of the cathode rays inside the vacuum tube. M. De Metz concluded from his experiments that the cathode rays had a photographic action on a sensitive film. M. Poincaré objected to this conclusion, because there was nothing in M. De Metz's experiments to show that the cathode rays were not transformed into X rays by their impact on the cardboard or aluminium sheet which covered the sensitive pellicle. An exhaustive series of experiments carried out by Battelli, and described in *Nuovo Cimento* (April, p. 193), appears to settle this doubtful point, and to throw a great deal of light in other respects upon the origin of the Röntgen rays, and their relation to the cathode rays.

The following are the conclusions which Battelli deduces from his experiments:—(*a*) The rays which proceed from the cathode in the inside of the discharge tube have a photographic action. (*b*) Such action is found even when the

* Electrical Review, Vol. xxxviii., p. 658.

characteristics of the cathode rays, properly so-called, have not been observed in the tube. (*c*) This photographic action augments with the increase of the rarefaction (at least down to a pressure of $\frac{1}{200}$th mm.). (*d*) Among the rays capable of producing a photographic impression, some are deflected by a magnet, and others are not. (*e*) From this it may be concluded that the Röntgen rays exist already inside the tube (before collision with an anti-cathode); and the same may be said of the rays studied by Lenard. The former would pass more readily than the latter through the wall of the tube, and hence the latter only would pass outside a tube of considerable thickness. (*f*) To say that the Röntgen rays are produced in the tube along with the ordinary cathode rays, does not contradict experiments made by myself and others, according to which the Röntgen rays apparently originate from the point where a material object is struck by the cathode rays. It is evident that the obstacle may act upon the cathode rays either as a filter or as a diffuser to send them off in all directions.

To demonstrate the photographic action of the cathode rays, Battelli wrapped a strip of sensitised film round a short length of brass tube. This sensitive paper was then covered

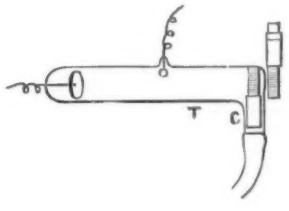


with black paper, so as to effectually exclude the ordinary light. The paper was divided into four segments, and over each was placed a wire pattern, or design, outside the black covering paper. The tube was then placed transversely inside, and near the middle of, a Crookes tube, so that one segment was exposed to the cathode rays, the opposite segment to the anode, and the two lateral segments to the phosphorescent sides of the tube. The results of one series of experiments were as follows:—

Arrangement of experiments.	In front of the cathode.	In front of the anode.	At the sides.
I. — Design in iron wire. Exposure, five minutes.	Sensitised film, strongly impressed with very distinct image of the design.	No impression.	Slight fogging on the border turned towards the cathode.
II.—Design in brass wire. Exposure, five minutes.	Strong impression, with very good projection of the design.	Very weak impression.	No impression.
III.—Design in aluminium wire. Exposure, five minutes.	Strong impression, with good projection of the design.	No impression.	No impression.
IV. — Intricate design of brass wire and aluminium wire.	The impression from the brass wire was somewhat more marked than that from the aluminium, but the difference was not so great as usually observed outside the tube.	No impression.	No impression.
V. — Design in brass wire and in magnesium wire of the same thickness.	Very marked impression, but much less from the magnesium wire than from the brass wire.	Very faint impression.	Very faint impression.

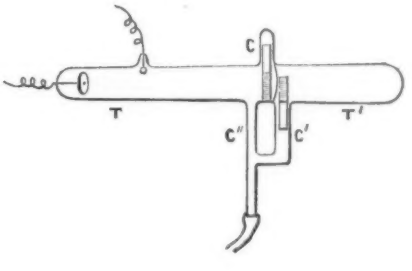
These experiments show that a photographic film is impressed by the direct action of the cathode rays, even when it is not affected by the fluorescence of the sides of the tube. Since metallic objects placed on the paper leave their shadow on the film, it appears to be proven either that the cathode rays have this property, in common with the X rays, or that they contain the X rays. There is, however, a grave objection to this argument, namely, that the phenomena described may be explained, as suggested by Poincare, by the assumption that the cathode rays, by striking against the paper cover of the photographic film, are converted into X rays. These X rays would then produce the photographic impressions of the wires on the film. The fact that the fluorescent sides of the tube produced little or no effect might be due to the fact that they were not so directly struck by the cathode rays, and were considerably further off than the paper.

Battelli now proceeded to devise and carry out experiments which would decide between these rival hypotheses. He took two pieces of photographic film, mounted on brass tubes and covered with black paper, as already described, and placed them both close to the anticathode end of a Crookes tube, but placed one inside the tube and the other outside. The cathode discharge was then turned on for a short time only to emphasise any difference in the impressions produced on the two films. In all the experiments the impression made on the film inside the tube on the face turned towards the cathode was always enormously greater than that produced on the external film. This shows that the fluorescence of the anticathode has a far weaker photographic effect than



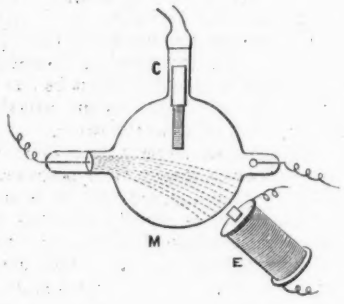
the direct action of the cathode rays. Similar experiments were made opposite the anode, and at other parts of the tube, and all the results were absolutely in favour of the hypothesis that the cathode rays contain the Röntgen rays.

To make the condition of the external film approximate still more closely to that of the internal film, it is enclosed in an exhausted chamber fused on to the end of the Crookes tube. At pressures higher than $\frac{1}{30}$ mm. an impression was obtained on the internal film when no impression was made on the external film. At pressures between $\frac{1}{100}$ and $\frac{1}{200}$ mm. both films were blackened, but the internal film much more than the external film. Other experiments were made with designs made of glass thread, which showed conclusively that the photographic action was not due to the collision of the cathode rays with the paper envelope.



Battelli next arranged an experiment to explain, if possible, the different behaviour of the cathode rays and the X rays in the magnetic field. If the conclusion is correct that the X rays are present in the ordinary cathode rays, how is it that the X rays inside the tube are deflected by a magnet, while those outside are not. The solution was found to be that a part of the ordinary cathode rays are not deflected by a magnet. When a film is placed in a Crookes bulb so as to lie in the normal path of the cathode rays, and the cathode rays are then deflected by a magnet so as to pass beneath the film, then it is found that a photographic impression is still made on the film by some invisible part of the radiation

from the cathode, which has not been deflected by the magnetic field. Further experiment, however, showed that the rays deflected by the magnet had also a photographic action.



Battelli also made experiments to discover at what internal pressure the photographic action of the cathode rays commenced inside the tube. He found this action inside the tube at a pressure of 3/10 mm.; it increased very rapidly down to a pressure of $\frac{1}{170}$ mm., after which it apparently remained constant. At a pressure of 2/10 mm. the tube had no action on a film outside the tube, with an exposure of more than three hours.

We have no hesitation in saying that Battelli, by means of these interesting and ingenious experiments, has made the greatest advance in the theory of the X rays since their discovery by Röntgen.

An important practical improvement in the construction of X ray tubes has been made by Mr. Pike, consulting engineer to the Vacuum Tube Company. An important item in the cost of X ray tubes is the time required to produce the very high vacuum required for an efficient tube. This takes, for example, about four hours for a focus tube. Mr. Pike has succeeded in reducing this time to two hours, by fixing two additional electrodes in the tube at a short distance apart, and sending a powerful current from a transformer across the gap between them. The electrodes are made of metals which are absorbent for the gases in the tube. The tube is first exhausted to a moderate extent by a Fleuss pump, and then the discharge is passed between the two additional electrodes. In some way, not yet fully explained, the vacuum is rapidly raised to the required standard, without further use of the pump. Mr. Pike discovered this interesting fact about two years ago, when he attempted to fit up an installation of Geissler tubes for Mr. Kiralfy. This curious phenomenon was fatal to the permanent working of an installation of vacuum tubes, since in the course of time they run themselves out of action. Tesla and several others have recently noted this peculiar action of a discharge on the vacuum tube, which Mr. Pike has turned to such good practical advantage.

Several sensational announcements have appeared in the daily papers as to startling advances that have been made in Röntgenography. The General Electric Company, Berlin, is said to have improved the tubes so much, that the heart and lungs could be distinctly seen on the phosphorescent screen. From the somewhat vague reports in the newspapers, the improvement appears to be merely in making the vacuum in the tube very high—equal to an 8-inch spark in air.

Edison and Tesla are credited with having lined the X ray bulb with a phosphorescent material, and obtained thereby a light ever so much more efficient than the now effete glow lamp. These two trans-Atlantic gentlemen have more than once already made the unexpected happen, and, oftener still, have led us to expect what did not happen; therefore we suspend our judgment, and wait for further details.

Röntgen Photography.—At the Athenæum, Camden Road, N., on Friday last, Mr. W. H. Marshall lectured on "Photographing the Invisible." Mr. G. C. T. Bartley, M.P., presided.

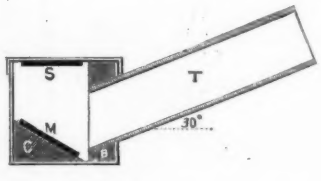
CORRESPONDENCE.

Vacuum Tubes for X Rays.

When experimenting with focus tubes which have normally too high a vacuum, and therefore require occasional heating by means of a spirit lamp in order to obtain the best results, it is sometimes not easy to determine when the desired degree of vacuum has been obtained and whether the radiation is of that form which distinguishes best between flesh and bone.

It is quite possible for the external appearance of the tube to be sufficiently brilliant, and yet for a radiation to be given off to which flesh is opaque, this is usually due to the vacuum being too low, while if the vacuum be too high the rays emitted pass through the bone as well as the flesh, the result in either case being unsatisfactory.

In order to see during the actual taking of a Rontograph whether the proper rays are being emitted, I have found the following simple contrivance very useful. It consists of a small cardboard box about 2½ inches cube, into one side of which is fixed, at an angle of 30°, a cardboard tube, T, of about 1¼ inch internal diameter. A block of wood, B, cut so as to fit the tube and the side of the box forms a strong



joint. On a block of wood, C, with a sloping face of 30° is placed a mirror, M, which reflects the image of a fluorescent screen, S, up the tube, T, to the observer's eye. All the joints are made to exclude light.

During the operations in whatever position the vacuum tube happens to be the operator can easily satisfy himself as to the character of the rays by placing his finger on the lid of the "ray-tester," holding it anywhere within the field of radiations and looking down the tube, T. Until a satisfactory result is obtained on the screen it is of no use proceeding with the experiment.

In long exposures the rays can be constantly examined and the most favourable conditions maintained by occasionally heating the tube or altering the spark length.

H. Osborne Mance.

June 6th, 1896.

Storage Batteries for Traction Purposes.

In your issue of the 5th instant I notice several remarks on storage batteries, and, as my name is mentioned, amongst others, I have taken the liberty to write you on this subject.

There appears to be considerable doubt in the minds of some as to the actual improvements which have been made during the last few years in storage batteries, especially for traction purposes. This is, doubtless, due in some measure to the unostentatious manner in which these improvements have developed. They have been gradual, and represent the outcome of immense labour and endless experiments.

As an instance of the improvements which have taken place in traction cells, I may perhaps be allowed to mention that whereas the cells used by me for tramcar work in 1885-6-7 (which were of the "Plante" type) weighed 76 lbs., having a capacity of 120 ampere hours, I am now manufacturing cells on the "Plante" principle, which, for a weight of 72 lbs., give an output of *360* ampere hours!

If other workers in secondary batteries can report similar advancement, I think it must be fairly conceded that storage batteries have been improved, and that for street traction electricity by means of accumulators is the only practicable and satisfactory—as it is the ideal—method of working.

The argument frequently used against electrically propelled vehicles, that they are only possible where charging stations are within reach, will speedily disappear when the number of vehicles on the road prove the demand for current, and I am of opinion that the recharging of the cells on road cars will

be a satisfactory solution to the much debated "day" load at the various lighting stations throughout the country.

I must apologise for occupying so much of your valuable space, and trust you may find room for this letter.

C. P. Elieson.

London County Council and the Tramways.

I quite agree with the remarks made by your correspondent, Mr. Lea, this week, that the system to be used in the suburbs is undoubtedly the overhead wire with a swivel trolley, as this, I think, reduces the cost of the erection of the overhead wire by allowing it to vary from the exact centre of the line, and another point to be kept in mind is the probable extension of arc lighting and the possibility of using the poles carrying the wire to also carry the arcs, and thus save expense. As, for instance, the arc standards in Euston Road would require very little alteration to carry the trolley wires, which would in no way interfere with the light; or, if in narrow streets when span wires have to be used, a lamp on every alternate pole on either side would give a very effective light, and by the use of frequent feeding points the overhead wire could be kept down to its smallest diameter allowable with mechanical strength, and so not offend the eye. I think the Council should most certainly view erected lines on both trolley and conduit system, as it may be compulsory to use the latter, say from Victoria Station to Liverpool Street, but the Inspection Committee should certainly be accompanied by an expert in tramway work to tell them what to look at and when to look for it. If it were possible, I think a saving of time and money would be obtained if this Committee were split up and inspected various systems at the same time, each with its expert who would assist in drawing up a report which might be presented to the consulting electrical engineer to the Council, and who would be able to go straight to work on practical reports without having to sift them, as would probably be the case if the Committee went alone.

Another point is that there need now be no fear of obstruction to fire escapes moving about, as with the new horizontal escapes these can easily be moved under the wires. I have frequently heard this urged as an objection to the overhead wire, but it is no longer a fact to be taken into account.

R. H. Willis.

I may take the opportunity of making a suggestion which no doubt has occurred to others, but which, so far, does not appear to have been acted on, the adoption of which, however, would, I think, lead to an easy solution of the whole question.

It is that the London County Council should follow the example of other Corporations in the Kingdom, and send a deputation to the Continent and study the question of electric traction at Hamburg, Hanover, Budapest, Milan, Rouen, and other places.

It seems a pity, when so much evidence of a practical kind is available, not to make use of it.

E. Garcke.

June 9th, 1896.

[No doubt the County Council would appreciate the pleasures of a Continental tour as highly as other Corporations do, but why go so far afield; surely they might study the question of applying electric traction to English towns at Bristol, Blackpool, Coventry, Dublin, and South Staffordshire.—Eds. Elec. Rev.]

I should like to add a few words to this discussion. The London County Council has purchased certain tramways, and is purchasing others.

It has been proved by experience that electricity (supplied otherwise than from batteries carried in the cars) is the cheapest and best form of motive power for tramways, and that the single trolley system with overhead conductors is a simple and certain system, the only objection raised to it being that it is unsightly.

I venture to submit that the London County Council should, without any delay, *test* the validity of this objection.

They can do this in one way by visiting those towns where the system has already been adopted.

But better still, they can equip, say, a mile of tramway in London on this system, arranging for the supply of current temporarily from one of the existing electricity supply companies.

Let them do this, and there is little doubt that the objections that sound formidable when eloquently voiced in their Council Chamber, will melt away so quickly that members will hardly believe that they were ever seriously put forward.

On the other hand, if my anticipations are wrong, the way will be cleared, and a great incentive given to inventors to show a thoroughly efficient system that can be worked cheaply without the aid of overhead conductors.

Sydney Morse.

Motor Carriages.

In your last issue I noticed a criticism of an article of mine which appeared in the *Pall Mall Gazette* of the 29th ult., and in justice to myself, must ask you to insert this reply in your next issue. Far be it from me to impute malicious motives, but to say that your remarks are unjust would be using a very mild term indeed. You have so mixed the paragraphs, and distorted my meaning, that, were it not for the eminent authority you quote in your support, I should have deemed it unworthy of notice.

In writing the article referred to, I made no attempt to give a technical description of mechanically driven carriages, but simply a brief summary of the matter (as stated therein) that would be interesting to the general public. As to my motives in writing the article, they were the very reverse of those you impute to me, and if you will take the trouble to read it, you will find in one of the concluding paragraphs these words: "But the public must be careful with regard to investment in horseless carriage ventures."

My remarks as to the simplicity of driving refer to motor carriages in general, and not to the Daimler motor in particular, as you infer; but as you quote Sir David Salomons on this point, I will give you his opinion of the Daimler motor, as expressed in his pamphlet "The Horseless Carriage." He says: "I spent one afternoon in examining the machinery in detail; the second afternoon I took the carriage out with an instructor, and the third day I went out with a boy who understood the details of the engine, to avoid the necessity of personal attention, if needed (?). The next day I went out by myself, and was quite *at home with the vehicle, as if I had driven it all my life*." And further on he says, referring to the exhibition at Tunbridge Wells: "I know that with horses it would not have been an easy matter to thread one's way in and out on that occasion, yet with the self-propelled trap there was no difficulty, which speaks highly for the mechanism of these vehicles."

With reference to the opinion I express that electricity will be the power of the future for the horseless carriage, you quote Sir David to the effect that "Electricity is practically out of it for the present." What possible bearing this can have on my remarks you know best, but I very much doubt whether Sir David Salomons believes that finality has been reached in the design of accumulators.

Referring to Mr. Radcliffe Ward's experiment, your knowledge of this subject is of a most meagre description. The 5,000 miles run does not embrace a period of eight years, as you imagine, but only about two years (1889—92). This experiment demonstrated that a service of buses could be run for 2½d. per car mile, and the watts that would be consumed per ton of rolling weight were ascertained. The accumulator used in this bus was considerably heavier than the London Electric Omnibus Company propose to use now.

You challenge me to name any new accumulator possessing the necessary qualifications for successful traction work. I simply mentioned improvements, not new accumulators, but may point out that in Paris the Laurent-Cely accumulator has been used with great success in tramcar work for some three years past; the cost of working is less than with horse cars, although there are a number of heavy inclines. There are, I believe, about 50 cars in use. (See your own article on this subject in the Electrical Review for August 2nd, 1895). I may also refer to a note of yours in the Electrical Review for September 6th, 1895, where you say:—"In the discussion on Mr. Perry's paper at the Londonderry meeting of the Municipal and County Engineers, Mr. E.

Pritchard, of 'London and Birmingham,' stated that the use of electricity and tramway traction by means of accumulators had been a financial failure. *This assertion could only have been made in ignorance of what has been recently accomplished*, and we would refer Mr. Pritchard to our recent analysis of the figures relating to the St. Denis (Paris) line for correction thereof."

To name all the improvements in accumulators patented since 1892 (the date of completion of the experiment mentioned) would occupy too much of your valuable space, so I must refer you for information on this point to the Patent Office library.

You refer to several well-known types, probably having in mind the Birmingham tramways. I believe the accumulators first used on this line were intended for lighting purposes, and success with them could hardly be expected. One of the chief reasons why accumulators are found wanting in tramcar work is, that they are subjected to severe usage in starting; it cannot be expected that an accumulator whose best rate of discharge is 50 amperes, will stand 200 amperes frequently without damage, disintegration of the paste being much more rapid under such circumstances. A means of avoiding this to a great extent is by means of a variable speed gear.

In conclusion, I may state that I am not commercially interested in manufacturing or contracting firms connected either with motor carriage work or any other branch of engineering, which I consider to be a necessary qualification of an honourable consulting engineer, in order to be in a position to give unbiassed advice.

F. J. Warden-Stevens.

[We willingly insert this letter, for nothing could be more to the purpose for proving our contentions right up to the hilt. So far as motive was concerned, that was very clearly expressed in our third paragraph, but how the paragraphs which were culled, without altering a word, from our correspondent's article, have become mixed, or how his meaning can be any different in our pages to what it was in the columns of the *Pall Mall Gazette*, is beyond our comprehension. He asserts that his remarks on simplicity in driving refer to motor carriages in general, and not to the Daimler motor in particular, as we infer. What other inference could we draw from "the oil motor, which seems to have achieved the greatest success, so far, is the Daimler." And how does the quotation from a prior pamphlet of Sir David Salomons mend matters? After four days he was probably quite at home with the vehicle mentioned, and from an extended experience he now gives an opinion quite at variance with that of Mr. Warden-Stevens. We did not say that the question put to Sir David by the representative of our contemporary, *Commerce*, had any bearing on Mr. Warden-Stevens's remarks, but the lines preceding that question, based on an intimate knowledge of electric traction, rather conflict with our correspondent's mere opinion, and now we come to that part of his letter which reflects upon our knowledge, and beyond which we need not enlarge to any extent. "The 5,000 miles run," says Mr. Warden-Stevens, "does not embrace a period of eight years, as you imagine, but only about two years (1889-92)."

We do not generally leave much to imagination, and, as the following quotation from the prospectus of the London Electric Omnibus Company, which we have now before us, will show, we can only conclude that our correspondent's information is not based on facts, or that the prospectus is misleading. "An electric omnibus was constructed in 1888, with a view to ascertaining the exact requirements necessary to a vehicle adapted to run on the streets of London. *The tests began in that year, and have been carried out continuously, and the omnibus has run upwards of 5,000 miles with remarkable success.*" Word quibbling does not make the case of Mr. Warden-Stevens any stronger—rather the reverse. We did challenge him "to name any new accumulator, &c.," but, in addition, we requested him to have the goodness to inform us of the great improvements "made in accumulators since Mr. Ward made this experiment," having in mind the above extract from the prospectus. We now leave Mr. Warden-Stevens to reflect on the realisation of his golden dreams of fortune on 2½d. per bus mile (demonstrated), and on the confusion which he has made worse confounded, although it would be an easy matter to keep on in the same strain.—Eds. Elec. Rev.]

To a Correspondent.—We have received from J. M. B. a letter criticising R. P. S's article on "Some Reflections, and a Moral," which appeared in our last issue. If J. M. B. will send us his name and address (not for publication) we will publish his communication.

LEGAL.

Electric Construction Corporation *v.* South Staffordshire Tramways Company.

Judgment.

In the Chancery Division of the High Court of Justice on Tuesday, the 9th inst., Mr. Justice Romer gave judgment in this action, which came before the Court at the latter end of April, and occupied five days in the hearing. The action was brought to recover certain sums due under an agreement dated February, 1892, and the defence set up was, that the Court could not enforce specific performance. The defendants further counter-claimed that the agreement was not binding upon them, asking for rescission and relief by way of damages.

His Lordship said that, seeing how disastrously to the defendants the contract in question had resulted, he was not surprised that the shareholders should view it with reluctance, and endeavour, if possible, to escape from its provisions, and having regard to the way in which the defendants had been, as it would appear, defrauded by their official officer, Wain, and their solicitor, Ebbsmith, that they should imagine it was brought about by sinister influences and dishonest purposes, and that it was not in the true interests of the defendant company. But the contract had been carried out by the plaintiffs, and ought not to be set aside, unless the defendants established a case that would justify the Court in refusing to hold it binding upon them. That the defendants had not done to his satisfaction, and, notwithstanding his sympathy with the company, he must hold the contract binding. The main defence to the action and ground for the counter-claim, was that the contract was fraudulently brought about, that it was onerous on the defendants, that it was impossible to carry it out, and that it was *ultra vires*, and could not be enforced. But the defendant's counsel had not been able to show him sufficient reason for holding it to be *ultra vires*. It was urged by them that the £15,000 debentures were issued and taken by them at a discount, but the contract would not on that account be *ultra vires*. Reliance was also placed on the fact that the tramways were parted with by the defendants before the plaintiffs had done any work under the contract. Though that might show indifference on the part of the directors of the defendant company, it could not be held as invalidating the contract. The main contention broadly urged before him was that the contract was brought about as part of a far-reaching, fraudulent scheme by Wain and Ebbsmith. No doubt Wain and Ebbsmith had defrauded the company, but he could not say the contract was a fraudulent one. Its terms were the subject of careful consideration by both companies, and considerable negotiation between them, which seemed to him to have been fairly and honestly conducted. The contract was not a profitable one to the plaintiffs, and probably would not have been entered into but for the hope that it would lead to more beneficial arrangements. No doubt it was onerous to the defendants, but they could not have carried out the work without some such contract, and having regard to the risks run by the plaintiffs, he could not say upon that account the full terms of the contract were unduly onerous. It might have been more prudent not to have adopted an electric system, and no doubt all concerned were too sanguine as to the beneficial results likely to follow its adoption. It was easy to be wise after the events had happened, and for experts to come forward now and say it was a contract that could not be carried out by the defendants; but at that time electricity, as applied to tramways was practically a novelty in this country, and it could not be seen that it was not likely to prove beneficial, and to be carried out to the satisfaction of both companies. On this part of the case, he did not think that reliance could be placed on Mr. Parker's present memory, that he advised the directors of the plaintiff company that the contract could not be carried out. It was contradicted by Mr. Courtney, whose evidence he accepted, and he thought Mr. Parker's opinions were better explained by his letter of December, 1891. The defendants were advised on the matter by their engineer, Mr. Dickenson, and notwithstanding the reflections made upon him, he saw no reason for holding that Mr. Dickenson did not honestly advise them at the time. The only provision in the contract to which strong objection was taken was that enabling the plaintiffs to bring the agreement to an end if the directors of the company should, otherwise than by death or voluntary resignation, cease to be directors. But at this time the frauds of Wain were not known; he was regarded as a gentleman of high character, and of skill as a tramway expert. Though the provision was one that might have worked hardly against the defendants, it was one in favour of the plaintiffs which they could, and did, waive, as it had never been acted upon. Under these circumstances, it appeared to him impossible, now, to make the existence of the provision in the contract a ground for upsetting the contract, or refusing to enforce its other provisions. With reference to Clause 3, the defendants sought to make something of the fact that the debts of £4,000 were not paid by the plaintiffs'

directors, but were paid to the defendants, who paid them, and it seemed unnecessary to see whether they were paid out of that particular £4,000, or the general moneys of the defendants. With reference to the payments to Mr. Dickenson, the view urged by the defendants had not been established before him; he did not see that these payments were a bribe to him, or that he had not done his duty by the defendants during the maintenance of the contract. It appeared to him a proper arrangement that they should employ the engineer of the defendant company, who had to look after the other sections of the line, and to pay him for his services. He had now dealt with the main question, and all he need further consider was a minor detail on Clause 16 of the contract. It was said on behalf of the defendants that the cost of working the electric tramways was about 3d. per mile travelled, and that to pay 4½d. per mile under Clause 16 was excessive, and must be regarded as in the nature of a penalty. But the clause spoke of 4½d. as an agreed sum, and it appeared to him it was in no way in the nature of a penalty, because if bound to exercise the power of bringing the agreement to an end, the risk or loss to them would, or might have been, very great, and he thought the 4½d. might be properly taken as the sum compensating them under the circumstances, as under Clause 16, the plaintiffs might not obtain the £16,000 therein mentioned, but might find themselves saddled with what might be to them useless land, cars, &c. It was admitted there must be an account taken of what was due on the contract, and he therefore declared the contract to be binding upon the defendants, and that under Clause 16 it was ended on December 14th, 1894, and on that footing he directed the account to be taken, the defendants undertaking to account for all costs occasioned by them. He would adjourn further consideration to Chambers, with liberty to apply, and with liberty to apply generally. As to the costs up to and including trial, the defendants must pay the plaintiffs' costs of the action. The counter-claim wholly failed, except as to the sums the plaintiffs had undertaken to account for; he therefore ordered the defendants to pay the costs of the counter-claim, except so far as they had been increased by the plaintiffs not admitting the sums to be accounted for by them, and in respect to those he ordered the plaintiffs to pay them, and for them to be set off.

Mr. Oswald said that as this was a matter of life and death to the defendant company, he would ask for a stay of execution if the appeal was brought in reasonable time.

Mr. Justice Romer then directed the account to proceed, but if taken before the appeal was heard, gave liberty to apply again.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending June 9th, 1895.	£	s.
Algoa Bay	224	0
Amsterdam	20	0
Bilbao	13	0
Buenos Ayres. Teleg. mtl.	822	0
Bombay	46	0
Cape Town	108	0
Delagoa Bay	184	0
East London	1,033	0
Freemantle	26	0
,, Telephone ...	434	0
Gothenburg. Teleg. wire	30	0
Launceston	190	0
Lisbon	589	0
Marseilles	18	0
Penang. Teleg. mtl. ...	145	0
Piræus. Teleg. mtl. ...	30	0
Port Natal. Teleg. mtl.	216	0
Rosario. Teleg. mtl. ...	50	0
Shanghai. Teleg. mtl....	45	0
Singapore	36	0
,, Teleg. cable	52,420	0
Wellington	418	0
,, Teleg mtl. ...	277	0
Yokohama	29	0
Total	£57,403	0

Week Ending June 9th, 1896.	£	s.
Alexandria. Telephone stores	38	0
Amsterdam	50	0
Auckland	45	0
Bombay	39	0
Brisbane	6	0
Buenos Ayres	269	0
,, Teleg. mtl.	26	0
Calcutta	270	0
Cape Town	160	0
Colombo. Telephone ...	110	0
Durban	17	0
La Plata	299	0
,, Teleg. mtl. ...	601	0
Port Elizabeth	138	0
St. Petersburg	136	0
,, Teleg. mtl.	81	0
Shanghai	43	0
Singapore	17	0
Stockholm	18	0
,, Teleg. mtl.	37	0
Sydney	265	0
Trieste. Teleg. mtl. ...	1,113	0
Wellington. Teleg. mtl.	77	0
Total	£3,785	0

Catalogue.—Messrs. John Turner & Sons, of Denton, near Manchester (whose London representative is Mr. C. F. Quicke, of 72, Finsbury Pavement), have just issued a catalogue of dynamos, motors, and coupled plants, for electric lighting and transmission of power. The list contains several illustrations of the firm's works, also some excellent process blocks of the engines, dynamos, and various electrical apparatus manufactured by them. Specifications of machines, price list of "T.D." compound dynamos, "series" wound dynamos for arc lighting, a table showing output at various speeds, are given, also particulars of steam engine coupled plants, electromotors of high efficiency for heavy constant work, motor fans, switches, and switchboards.

Committed for Trial.—William Morris, who for 23 years was accountant and cashier to Messrs. Elliott Bros., of St. Martin's Lane, London, was on Wednesday committed for trial by Mr. Hannay on a charge of having appropriated over £3,000 of the firm's money by "cooking the books."

Bankruptcy Proceedings.—In the Edinburgh Sheriff Court on 8th inst., Charles Gordon Stewart, electrician, 11, Roseburn Place, Edinburgh, appeared for examination under a petition for cessio. No questions were asked, and the petition was granted, Mr. R. A. Craig, C.A., being appointed trustee. The state of affairs showed the assets to amount to £15, and the liabilities to £147 2s. 6d.

Dissolutions of Partnerships.—Messrs. Dewhurst and Russell, of West Kensington, have dissolved partnership from May 30th. Mr. Dewhurst continues the business at West Kensington, and will attend to the debts of the late firm. Mr. Louis Russell is starting an electrical business in Bexhill-on-Sea.

We are informed that the partnership some years ago subsisting between Mr. A. Shirlaw and Mr. C. J. Thursfield was dissolved on May 31st, 1889, by mutual consent. Mr. Shirlaw sends us a circular stating that he has since carried on the business alone, and for his own sole benefit, but under the old style of "A. Shirlaw & Co.," at Suffolk Works, Oozells Street, Birmingham.

Messrs. Wm. Fox, A. Jeffery, and T. E. Rowe, hitherto carrying on the business of electrical engineers at 64, Fountain Street, Manchester, under the style of Wm. Fox & Co., have dissolved partnership so far as concerns A. Jeffery. The two other partners will continue the business under the old style, and will attend to debts.

Chamberlain & Hookham, Limited.—This company announce that they have appointed Mr. J. G. Statter, late of Victoria Street, S.W., to be manager of their dynamo factory, which branch of the electrical business the company intend to increase and develop. In regard to this appointment, we understand that the company takes over the whole of Mr. Statter's goodwill and manufacturing connection, also patterns and drawings. Messrs. Venner & Sillar, of 10, Delahay Street, London, will act as the company's selling agents throughout Great Britain and Ireland.

Elmore.—Unfortunate Elmore shareholders continue to ventilate their grievances in the columns of the financial press. The repeated promises of Mr. Wm. Elmore and the old directors are brought forward again and again to show how misinformed or oversanguine were those who held out these promises. Some of the English companies continue their dividendless careers, though the parent company seems to be turning the corner in certain respects, and if the shareholders patiently hang on they may have a dividend by the end of the century. It appears, from the fact stated by a shareholder, that the French company which M. Secretan took over, has just declared a dividend of 5 per cent. per annum for 1895. Can it be taken for granted that the dividend has been earned on actual working, and not derived from paper profits?

Exeter Electric Lighting Company, Limited.—In the Chancery Division of the High Court on Thursday last week, before Mr. Justice North, the case of Franklin and Gould *v.* The Exeter Electric Lighting Company, Limited, was heard. Mr. Jenkins, for the plaintiffs, the trustees for the debenture-holders in the company, said the company had entered into an agreement with Exeter Corporation for the sale of their undertaking to the Corporation for £7,500, which agreement would take effect on 30th inst. The only assets of the company outside this sale to the Corporation consisted of book debts and a few chattels, amounting altogether to about £1,000, so that the whole assets of the company amounted to £8,500. As the debentures amounted to £12,000, there was a considerable shortage. The company was in difficulties, and there were debts which it could not pay. One of the unsecured creditors was sueing the company, and the debenture-holders' trustees had brought this action to enforce the security under the debenture deed, and to ask for the appointment of a Mr. Knill as receiver, with power to manage until the sale to the Corporation was carried into effect.—Mr. Broughton Edge said he was instructed to offer no opposition on behalf of the company.—Judgment for the plaintiffs for the amount of the security, Mr. Knill being appointed receiver and manager of the company, with power to act at once.

For Sale.—The Edison & Swan United Electric Light Company invite tenders for three semi-portable steam engines and boilers, now fixed at their Ponder's End works, and a gas engine and several vertical engines now lying at the Newcastle works. For further particulars see our "Official Notices."

Green's Economiser.—E. Green & Son, Limited, have orders in hand for the supply of their patent fuel economiser to the electric light stations at Chester, Harrogate, Bray, and Cheltenham.

Personal.—Mr. Reginald P. Wilson informs us that he has severed his connection with the British Thomson-Houston, Limited, and proposes to continue the consulting work in which he has been engaged for some years at 3, Prince's Mansions, Victoria Street, S.W.

Rooper v. F. H. Holmes & Son.—Before Judge Jordan, at Stafford, last week, Mr. W. O. Rooper, an electrical engineer of Stafford, claimed from defendants the sum of £37 odd, balance of account for electric lighting work and labour, and for goods supplied in connection therewith. Judgment for £28 14s. 8d., each party to pay their own costs.

Ship Lighting.—H.M.S. *Swordfish*, the first of the two new torpedo boat destroyers, built at Sir W. G. Armstrong, Mitchell and Co.'s Elswick Works, is engined by G. E. Belliss & Co., Limited. The whole of the machinery and boilers, as well as the air-compressors for torpedo work, the electric light plant, and other auxiliary machinery, were built by this company. Messrs. Belliss are now so busy with electric light orders for central station and other installations, that they have been obliged not only to largely extend their premises, but for the present, at least, to give up marine orders almost entirely.

The Consolidated Telephone Construction and Manufacturing Company, Limited.—The Consolidated Telephone Construction and Manufacturing Company, Limited, have placed a portion of their extensive new works at Coventry to the construction of alternate current transformers and main switchboards, &c. Several new features will be introduced to make their machine one of the most economical in the market, and they consider that under the control of their new works manager, Mr. S. Sudworth, so long associated with Mr. Gisbert Kapp, a well made transformer high in efficiency, and low in iron and copper losses is ensured. There is every possibility of the company having to build on the large piece of freehold ground belonging to them, their present commodious workshops being fully engaged for some time to come with orders for telephones and switchboards of all kinds.

The Coventry Electrical Engineering Company.—At the Coventry County Court, on 9th inst., a petition for the winding-up of this company, presented by Messrs. B. Verity and Sons, Birmingham, was down for hearing. Mr. Masser, who appeared for the petitioning creditors, said he had received a notice from Mr. F. Thomas Jackson, a creditor, that he should oppose the order. Mr. Wilks represented Mr. S. T. Peirson, the liquidator of the company. He (Mr. Masser) had seen both Mr. Wilks and Mr. Maddocks (Mr. Jackson's solicitor), and an arrangement had been made that the matter should be adjourned till next Court day. There was a receiver appointed for the debenture-holders, and a voluntary liquidator, so that the estate would not be affected. The judge granted the application.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—A member of the District Council recommends that all the electric lamps on the terrace shall be lighted. The matter will be considered.

Ayr.—At the last Council meeting there was a discussion as to whether Mr. Robert Hammond's services as consulting engineer should be retained for future extensions. A proposal dispensing with his services was rejected by ten votes to seven.

Bangor.—The City Council has resolved to "give effect to the resolution of the Council passed in October last to apply to the Board of Trade for a provisional order for establishing an electric light installation at Bangor."

Bearpark.—On June 2nd, the electric lighting of Bearpark Village and Colliery, near Durham, was inaugurated, the current being switched on by the Chairman of the Parish Council. The installation was carried out by Messrs. Cox-Walkers, of Darlington.

Belfast.—A sub-committee is to confer with the Electric Committee respecting a propcsal to utilise refuse for the production of steam power for the new electric lighting station.

Birkenhead.—It is stated that in a few weeks the Council will be ready to supply current for private lighting.

Bradford.—Last Friday, the foundation stones were laid of the new electric light station to be built in Valley Road, in the presence of a large number of Town Councillors and Corporation officials, including the electrical engineer, Mr. Gibbings. Speeches regarding the electric light undertaking were delivered by the Mayor, Messrs. Dixon and Speight, and others, after which dinner was served in the Council Chamber at the Town Hall.

Brandon and Byshottles.—Messrs. Straker & Love have renewed their offer to the District Council to supply the district with electricity, but the District Council has a leaning towards gas, and the offer has been set on one side.

Bristol.—The Council has decided to increase the salary of Mr. H. Faraday Proctor, the electrical engineer, from £260 to £400 per annum, rising, by annual increments of £25, to £500; Mr. J. R. Blackie is also to have an increase from £130 to £175, rising to £200.

Burnley.—The Electric Lighting Committee has been authorised to lay electric cables along Church Street and Ormerod Road, to supply 2,000 lights, at an estimated cost of £1,000.

Bury St. Edmunds.—At the meeting of the Town Council, on Tuesday, a report was submitted from committee, from which it appeared there had been various interviews with Mr. F. H. Medhurst, electrical engineer. The committee recommended that his scheme providing for an efficient system of public lighting, as also 2,400 lamps for private use, be (with the supplementary estimates) adopted and carried out, and that he be appointed consulting engineer, at a fixed fee of £1,000, with an additional £100 for the clerk of the works. According to the estimates of Mr. Medhurst, the cost would work out:—Estimate for private lighting, £13,000; estimate for public lighting, £5,000; No. 1 supplemental estimate, £1,900; No. 2 supplemental estimate, £400; engineer and clerk of the works, £1,100; total, £21,400, less £2,500 to be repaid by the gas company. An amendment in favour of a poll being taken was lost by 12 to 10, and the adoption of the scheme was adjourned for a month.

Canterbury.—We understand that at last week's meeting the Town Council appointed Mr. Hammond engineer to carry out the electric lighting works. A portion of the Miller's Field has been selected as a site for the central station.

Cardiff.—Complaints having been made of occasional failures of the arc lights in the market, the borough engineer has explained that these are in all probability due to a defect in the lamps. Additional lamps are to be erected with a view to distributing the light throughout the market.

Colchester.—Four schemes and tenders were received by the Electric Light Committee for the proposed electric lighting. Messrs. Christy Bros. estimated the cost at £12,881, and £147 for loan of plant for military hospital, provided 80 per cent. of the cost be paid on completion, and the balance after six months. For payment six months after completion they estimated £13,092. The Brush Company's tender was £12,076 15s., and £186 for loan of plant; Messrs. Siemens Bros. £11,477, and £375 for loan of plant. The Electric Construction Company undertook to execute the works on or before January 1st, 1897, provided the order was given before July 1st, and the Committee unanimously recommended the Council to accept their tender for the establishment of the installation at £10,675, and fixed charges in respect to current supplied for temporarily lighting the military hospital, the estimated amount being £257 10s. The Committee further recommended the Council to apply for the Local Government Board's sanction to borrow £15,000 for the purposes of electric lighting. These recommendations have been adopted by the Town Council.

Cork.—The three lowest tenders sent in for electrically lighting the Lee Road pumping station for the Corporation amount to £165, £178, and £187 respectively, and they have been referred to the engineers for report.

Darjeeling.—An Indian contemporary states that the Municipality has decided to lay down its own electric lighting installation.

Dewsbury.—The salary of the Corporation electrical engineer, Mr. J. B. Mitchell, is to be increased from £175 to £200 per annum. The charge for current for motive power purposes is to be reduced. Mains are to be laid at a cost of £450 for supplying the Dewsbury and District Technical School.

Eccles.—A Local Government Board inquiry was held on 3rd and 4th inst., regarding the Council's application to borrow £20,000 for electric lighting, and other sums. The Town Clerk, in his speech supporting the application, said the Manchester Edison-Swan Company offered to carry out the whole of the lighting works for £13,792, and adding to this the tenders for buildings, &c., the total was brought to £18,761, and 10 per cent. was allowed for contingencies. Mr. Clirehugh, the electrical engineer who was advising the Council, gave evidence regarding the scheme. He said the works would have a capacity for lighting 750 public lamps of 20 C.P., and 3,750 private 16 C.P. lamps. Mr. Fawcus, of the Manchester Edison-Swan Company, also gave evidence in support of the scheme.

Edinburgh.—A report submitted by Prof. Kennedy declares the works, plant, mains, &c., to be working satisfactorily, and there is the prospect that the cost per unit will be less this year than last.

Fareham.—The electric lighting works were the subject of discussion at the last District Council meeting. A report submitted showed that the estimated cost of carrying out the works, and the purchase of the plant, was £2,800, to which would have to be added £200 for piece of land adjoining the station; total £3,000. A further loan of £1,900 was required. It was proposed that the Council should at once enter into a provisional contract to purchase the plant. The report was adopted.

Garston.—The District Council will enter into an agreement with the Liverpool District Electric Lighting Company, embodying the condition on which the Council agree to withdraw its objection to the provisional order being granted to the company. A committee has been authorised to engage the services of a competent expert to confer and report with reference to the establishing of electric lighting in the district, either in connection with a refuse destructor or otherwise.

Great Yarmouth.—The Electric Lighting Committee reports that additional applications have, during the month, been received for 152 lamps, the total number of customers now being 172 for 8,143 lamps. The income last month was £133 2s. 2d., and the expenditure £128 17s. 8d., £4 4s. 6d. being earned beyond cost of production, while the repayment of capital, interest, rates, and insurances amounted to about £100 per month.

Grimsby.—The recommendation of the Public Lighting Committee that a dynamo (110 volts), costing £144 10s., be purchased from Messrs. P. R. Jackson & Co., was referred back by the Town Council last week. Some of the members thought the machine was not necessary.

Harrogate.—Some members of the Council think the laying of mains should be stopped during the season on account of the inconvenience in the streets, but the majority think otherwise, hence the work will go forward with all speed.

Hospital Lighting.—We understand that the cost of the substitution of electricity for gas at Netley Hospital is to be included in next year's Army Estimates. The cost is said to be about £8,000.

Llanelly.—Mr. J. C. Howell's proposals regarding electric lighting have been referred to a meeting of the whole Town Council.

Leamington.—The Council has asked the Midland Electric Lighting Company to estimate for lighting the Parade with arc lamps.

Lincoln.—A private installation has been put down by Mr. T. Scott Anderson, of Sheffield, at the cabinet making works of Messrs. Curtis & Mawer, Silver Street, Lincoln. A 6 H.P. Robey gas engine drives a Crompton dynamo. There are 60 32-C.P. incandescents and one 1,000 C.P. arc lamp.

A provisional contract is being entered into with Mr. C. A. Harrison for the purchase of a site (to cost about £1,500) for electric generating station.

Liverpool.—At the last City Council meeting plans and elevations were submitted of the buildings proposed to be erected in Paradise Street by the Liverpool Electric Supply Company. There was opposition by several members who thought a 160-feet tall chimney would be dangerous, and destroy the appearance of the neighbourhood. Other reasons were also put forward, but ultimately the plans, &c., were approved by 57 votes to 18.

London.—Mr. Brooke Hitching, at the last meeting of the Commissioners of Sewers, after referring to the high charge per unit made by the City Company as compared with other London supply companies, asked whether the Commission had reserved to itself the right of purchase from the company upon equitable terms, or if not, what notice would be required should the City Company desire to possess the electric lighting supply. In reply, Mr. Turner referred him to the contract entered into by the Commission of Sewers with the Laing, Wharton and Down Company, which was in effect that the Commission should have power to acquire so much of the undertaking for public lighting as was within the City district at the end of a term of 21 years, and upon such terms as were prescribed by Section 2 of the Electric Lighting Act, 1888. Further, it had the power to acquire the electric lighting undertaking for private lighting at a like period, either upon terms agreed to between the Commissioners and the directors, or, failing an agreement, then at a price fixed by arbitration in the manner provided by clause 16, and on both sides powers were to be without prejudice to the rights reserved to the Commissioners by the same section at the end of 42 years.

On the recommendation of the Building Act Committee, the County Council on Tuesday approved plans for the construction of additions to a building to be used in Chapel Place as a generating station for the Kensington and Knightsbridge Electric Lighting Company. The extension of mains and transformer boxes by various metropolitan electric lighting companies was sanctioned.

Morecambe.—The District Council has requested Mr. Thomas Parker, of Wolverhampton, to prepare plans, specifications, &c., for a proposed electric light installation costing £25,000. A site for the works has already been secured.

Motherwell.—The Police Commissioners last week decided by a large majority not to consider a proposal to proceed with electric lighting under the burgh provisional order; but a motion was passed resolving to take over the gasworks.

Oldham.—The Corporation electric lighting accounts are understood to show a net profit of over £800, and the price per unit to private consumers, as from March 25th, is reduced from 6d. to 4½d.

Plymouth.—As the Old Town Street, Ebrington Street, and Ham Street are now open for street improvements, the opportunity is to be taken advantage of for laying electric mains at a cost of £1,000, for the loan of which sum application is to be made to the Local Government Board.

Portsmouth.—The Electric Light Committee recommends the Town Council to purchase a new 1,000-H.P. engine for the electric light station at Portsmouth, and to borrow £10,000 with which to cover the cost of the engine and of cable required for the extension of the mains. The engine itself is estimated to cost £6,200.

Shoreditch.—There were 41 applications for the post of resident electrical engineer under the Vestry; from these, six have been selected to attend the next meeting of the Vestry.

Simla.—*Indian Engineering* says that although a goodly number of tenders for electrically lighting the Town Hall and principal thoroughfares have been received by the municipality, it is scarcely expected that any will be accepted, owing to the cost and to the little encouragement given to the idea by the tradespeople and private individuals.

South Shields.—The Electric Lighting Committee want an assistant for the borough electrical engineer, at £100 per annum, For further particulars see our "Official Notices."

Stowmarket.—Through the enterprise of Messrs. Peddur and Prentice, who have erected works and completed a circuit of wires in Ipswich Street and the Market Place at Stowmarket, the public and private residents now have the opportunity of using the light. On Saturday evening two arc lamps (2,000 C.P. each) were lighted outside Messrs. Turner & Co.'s premises for the first time.

Wakefield.—The printing works of the *Express* are now lighted by electricity. A special private plant provides the current. There are at present 43 lights in use.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Austria.—A company is being formed in Vienna, to be known as the Baden-Voslau Railway and Electrical Company, to acquire and work the electric tramway between Baden and Voslau, near Vienna.

Belgium.—A company has just been formed in Brussels with a capital of £40,000 to be known as the Compagnie Internationale de Traction Electro-Magnetique.

Buenos Ayres.—It is rumoured, says the *Financial News*, that the tramway companies of Buenos Ayres are contemplating the substitution of electricity for horse power, and if the change take place it will mean an important saving in working expenses. To give an example of the effect which such an alteration in motive power would have, it is calculated that the Anglo-Argentine Company would be able to work at 50 per cent. of the receipts as against 70 per cent. now, or in other words, to save £30,000 per annum—equal to an extra dividend of 2 per cent. on the shares.

City and South London Railway.—In the House of Commons, last week, on the consideration of this extensions Bill from Committee, Sir A. Rollit sought to move a clause providing that all lands and buildings in the parish of Islington taken for the purposes of the railway should remain rateable till they were used for the purposes of the undertaking, and while the works were in progress.—The Speaker ruled that such a motion could not be raised on the report stage of a Bill.—Sir A. Rollit then said he would move to recommit the Bill; but, objection being taken by Mr. Murdoch, the matter stood over.

Dublin.—The success of the Dublin electric tramways has been so great, that more cars have become necessary. Next week there will be a total of 30 sets of cars running.

Glasgow.—On 8th inst. the Tramway Committee of the Glasgow Corporation received from the Simplex Electric Tramway Conduit Syndicate, Limited, drawings and estimates for the application of the conduit system of traction in Glasgow. The *Glasgow Mail* says that the conduit is formed under one of the track rails, a slot ¾ inch wide giving access to the conduit, replacing the ordinary rail groove. "A flexible conductor is supported at intervals of 30 feet on hook-shaped arms carried on insulators. These insulators are placed in small chambers formed at the side of the conduit. The collectors consist of insulated conductors provided with U-shaped contact shoes carried in shanks, two collectors being attached to each car. The conductor is allowed to glide through these shoes, which pass over the supporting arms, the conductor being lifted during their passage, and falling back again after the car has passed. It is claimed that the whole of the roadway can be constructed before any of the electrical appliances are placed in position, and that when the line has been completed the insulators can be readily placed in the side hatchways by lifting the lids provided for that purpose. Assuming that the existing tramways are in good repair, the cost of the work is estimated at £3,000 per mile, single line of track, or £6,000 per mile double line of track. In cases where the tramway rails are not in good repair, the cost is estimated at £4,000 per mile of single line of tramway, or £8,000 per mile of double track. The company suggest, for demonstration, the Springburn route, and offer to carry out the whole work at their own expense. Should the installation give satisfaction, the Corporation will pay the cost of the work as per tender; but should the work not be satisfactory, they will only pay for so much of the work and rolling stock as they may be able to use for the purpose of an overhead installation should they decide on its substitution for the conduit system. The necessary power could be supplied from the existing electric light station, so that the existing plant might be utilised during the day, when there is but little demand for light, for the purpose of working the tramways."

Kidderminster—Stourport.—In the House of Commons on 8th inst., the Kidderminster and Stourport Electric Tramway Bill was ordered for third reading.

Leeds.—The Highways Committee want to acquire some land at Crown Point, owned by the Sanitary Committee, for the purpose of erecting thereon a generating station for the electric tramway undertaking.

London County Council and the Tramways.—The proposals made by the County of London Tramways Syndicate to the London County Council with a view to the latter purchasing the tramway system throughout the metropolis, and leasing the lines for 28 years to a company to be formed by the syndicate for their conversion from horse to electric traction, were briefly considered at Tuesday's meeting of the County Council. The recommendation of the Highways Committee that the syndicate should be informed that the Council was not prepared to enter into any arrangements with the syndicate on the subject of the tramways, was not adopted, an amendment being carried by 32 votes to 13 that the matter should be referred to the Finance Committee to consider and report upon the syndicate's proposal in all its financial bearings.

Manchester.—The Corporation has decided to apply for powers to take over and work the city tramways. As the Corporation has been so successful with its electric lighting undertaking, there is every reason to hope that electric traction will shortly be taken in hand.

The Metropolitan Railway and Electricity.—Last Monday and Tuesday nights, at a late hour, after the cessation of the usual traffic, the experiment was tried, according to several daily papers, of having loaded trains drawn on the Underground Railway in London by means of electrical power instead of steam.

Yesterday's *Daily Chronicle* had the following upon this matter:—"Inquiries made indicate that the hope of a smokeless Underground Railway is still quite in the future. It was ascertained that the experiments which have just been carried out on the line do not mean that the adoption of electricity is being practically considered. The strict purpose of the experiments was to ascertain the traction power which is needed to pull an average passenger train along. An ordinary locomotive and ordinary carriages were used—electricity did not come in at all—but no doubt the experiment bore in a way upon electricity. Engineers now recognise it as perhaps the great motive power of the future, and as applicable in particular to underground communication. In that regard an early thing to ascertain would be the amount of electric power needed—supposing it could ever be adapted—to propel an ordinary Underground train. That represents the whole meaning of the present experiments."

Wolverhampton.—We understand from a contemporary that it has been decided by the Town Council to refer the question of purchasing the local tramways to a committee, with power to obtain the advice of an expert on the subject of introducing some improved form of traction.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Ceará-Maranham	April 28th, 1896 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Bissao-Bolama	May 30th, 1896 ...	...
Cadiz-Teneriffe	June 7th, 1896 ...	...
Jamaica-Colon	June 10th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Mazol (Mashonaland) Telegrams for Tohikwawa and Blantyre cannot be accepted.	March 12th, 1896 ...	...
Bolinao-Manila—telegrams are sent by post	March 19th, 1896 ...	...
Communication with Cartagena and Barranquilla, Columbia.	May 22nd, 1896 ...	...
Columbia landlines. Telegrams for places beyond Buenaventura subject to delay.	June 4th, 1896 ...	...
Blagovestchensk - Radde (Siberia).	June 6th, 1896 ...	June 7th, 1896.
Siberian lines interrupted near Chabarowka	June 8th, 1896 ...	...

Cable Interruption.—It is stated that the submarine cable between Tangier and Spain has been broken near Melilla by contact with the keel of a passing vessel.

Ceylon Telegraphs.—We understand that Mr. Chas. E. W. Pennycuick (Chairman of the Municipal Council and Mayor of Colombo) has been appointed Postmaster-General and Director-General of Telegraphs in Ceylon.

Ludlow Telephone Service.—The Corporation have had the telephone wire from the Exchange vaults to the warehouse in Church Street cut, in consequence of the National Telephone Company refusing to enter into an agreement with them.

London—Paris Cables.—Replying to Mr. Henniker Heaton in the House of Commons last Friday, Mr. Hanbury said that the British and French Governments were agreed that at least one submarine cable for telephonic and telegraphic purposes ought to be laid, and the land lines to serve this cable were in course of construction. The question of a second cable was still under consideration. As a contract for the construction of the first cable had not been made, it would not be convenient to give an estimate of the cost. The expenditure on the cable and the receipts for the whole service would be shared equally between the two countries. Provision for the land lines and cable had been partly made in the votes of the last financial year and partly in those of the current year. No reduction in the charge for telephonic conversation with Paris was contemplated.

Reduction of Telegraph Rates to India and the East.—From the *Liverpool Journal of Commerce*, we gather that the East India and China Trade Section of the Chamber of Commerce has been in correspondence with the leading Indian Chambers on the subject of the high rate per word charged for telegrams to India, and it had been resolved by the Committee to recommend that a memorial be addressed to the Postmaster-General and the Secretary of State for India, and that a copy of it be sent to the Committee of Administration working the telegraph lines between this country and India, which meets at the offices of the Eastern Telegraph Company in London. These proceedings were confirmed. We, ourselves, are much afraid that a memorial addressed to the administration above-referred to will have little or no effect, as the Eastern Telegraph Company and the Indo-European Company work together under a joint-purse agreement, and there is, therefore, a lack of stimulating competition.

The Telegraph in Eden.*

Rare Chauncey M. Depew,
Your words are strong and true
When you deal with subjects social or didactic;
Your humour is entrancing
Whene'er you set it prancing
Round the board as a post-prandial prophylactic.

But when you go a-gadding
For metaphoric padding
Into fields where even Science goes astray,
You may miss what you are after
And cause mistaken laughter
In a crowd that does not question what you say.

There's that matter of the leaves
That formed our Mother Eve's
Sole costume in the Garden of her birth:
You prettily declare
Those "trifles light as air"
Were the first magnetic telegraph on earth.

If Scripture lore be true,
You're wrong, my friend Depew,
'Twas not the leaves excited Adam's passion,
An apple—as Eve ate it,
Poor Adam captivated
The leaves came subsequently into fashion.

—New York *Electricity*.

The Pacific Cable Conference.—The first meeting of the committee appointed to consider a scheme for establishing direct cable communication between England and Australia, *vid* the Dominion of Canada, was held at the Colonial Office last Friday afternoon. The Imperial delegates were the Earl of Selborne, Under Secretary of State for the Colonies, and Mr. G. H. Murray, C.B., a principal clerk in the Treasury; the Canadian Commissioners were Sir Donald Smith and Sir Mackenzie Bowell, with whom was Mr. Sandford Fleming, C.E., who is acting as their technical adviser; and the Australian representatives were Sir Saul Samuel and Mr. Duncan Gillies. Mr. Mercer, of the Colonial Office, Mr. Chamberlain's assistant private secretary, who had been acting as secretary *pro. tem.* to the delegates, stated on Friday evening to a *Times* representative that the committee had taken into consideration the question of making public from time to time the general course of their deliberations, and had decided that the meetings should be absolutely private, and also that no communications should be made to the Press after the meetings. It was, therefore, impossible to do more than give the names of those present and announce that it was decided at the initial meeting that Lord Selborne should be chairman and Mr. Mercer secretary of the conference.

Telegraphs in Siam.—When Mongsin comes under French administration, probably more will be heard of the project to link up the Indo-Burma telegraph system with the Tonkin wires. At present Kengtung is the terminus of the telegraph from Burma. The French wire stretches from Hanòi up the Red River to Mong Low Kai, and thence turns in eastward to Mong Lai. In the Mekong Valley the French have also run the telegraph to Keng-Kan, and have possibly extended it to Luang Prabang. The best route, according to *Ind'an Engineering*, for the connected line to take would be from Kengtung to Mong Lai, 230 miles.

The Telegraph Wire Export Trade.—The returns which are now available regarding the value of the exports of telegraph wire and apparatus connected therewith from this country, show that May proved to be an exceedingly busy month in this branch, the exports amounting to a total of no less than £112,215, as compared with only £23,066 in the preceding month, and £26,942 in May, 1895. The total for the first five months of the year is returned at £323,583, which compare very favourably with that for the same period of last year (£126,688). It is, however, still considerably behind that of the first five months of 1894, when the total exports amounted to £542,095.

The Telegraphic Isolation of England.—In the *Contemporary Review* for this month an article written by Mr. Percy Hurd appears under the above heading. The writer points out clearly the dangers to which our communication with our various colonies is subject, and refers more particularly to the unsatisfactory state of telegraph communication with South Africa during the recent troubles in the Transvaal. We ourselves at the time drew public attention to the lamentable state of affairs occasioned by the repeated interruptions of the East and West African cable routes, which afforded an object lesson from which much could be learned as to the insufficiency of the present cable systems uniting England with her colonies. There can be no doubt that the present routes to India, China, and Australasia lie quite open to attack, and could be immediately and easily interrupted in the event of international complications.

* At the Electrical Exposition on the evening when Mr. Depew's message was sent around the earth, his eloquent speech on the occasion was graced by some pretty conceits, one of which was that the foliage Eve adopted as a costume was "Love's telegraph of leaves," and therefore the first instance of telegraphic communication.

The Proposed New German Cable.—The chairman of the Brazilian Submarine Telegraph Company, when addressing the shareholders of that company recently, is reported to have spoken as follows:—"On this side of the Atlantic we have not been idle in the joint interest. Together with our allies, the Eastern Telegraph Company, and with the Telegraph Construction and Maintenance Company, we have joined in a new company called the German Telegraph Company, or, more correctly, the Deutsche See-Telegraph Gesellschaft, having for its object the laying of a cable from Emden, in Germany, to Vigo, in Spain, whence there is a short cable to Lisbon, where our main cable diverges. That new cable is in course of construction, and when we next meet I hope we may be able to report further with respect to it, but if our hopes are realised it should carry a valuable North European traffic for our route, much of which is now lost to us." From the above it will be seen that the German Government, with the assistance of the English companies referred to, is taking steps to arrange, as far as possible, that at least one foreign Government—England—shall be cut out of its line of communication. We have heard that this new cable is only the first link in a German system of cables, which is to be carried to the United States *via* the Azores. Into this system, doubtless, the existing cable from Portugal to the Azores will be absorbed, an arrangement easily effected, as the Azores cable is owned, we understand, by some of the above-mentioned English companies, to whom, no doubt, the operation will prove profitable. This extension to the United States will also have the effect of placing Germany in a favourable position as regards both North and South American traffic, as when it is carried out, telegrams from the Continent to South America can be transmitted by the Galveston or American route, without passing through England at all, and instead of traversing the lines of the Brazilian Submarine Telegraph Company, which is in English hands, will, in case of need, be enabled to go by the new route, over which the German Government will undoubtedly take measures to have complete control.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—June 28th. The last date for the receipt of tenders invited by the Municipal authorities of Prague, for the erection and equipment of a municipal electricity generating station in the town for electric lighting, power, and tramway traction purposes, has been extended from June 1st to the 28th.

Belgium.—June 17th. The Société Nationale des Chemins de Fer are re-inviting tenders for the contract for the conversion into electric lines of the following vicinal steam railways:—Joliemont-Carnières, Manage-Joliemont, Pont Broguiez-Haime-St. Pierre, Pont Brogniez-La Louvière-Houdeng, and Bracquegnies-Houdeng-Pont du Sart. The lines are all in the Centre district, and have a total length of about 20 kilometres. Particulars from, and tenders to, La Société Nationale des Chemins de Fer Vicinaux, 26, Rue de la Science, Brussels.

Burnley.—June 24th.—The Corporation requires tenders for the supply of armoured concentric underground cables. For further details, see our "Official Notices."

France.—June 16th. Tenders are being invited by the General Direction of the French Posts and Telegraphs for the supply of a quantity of miscellaneous chemical materials for primary batteries, in 12 lots. Tenders to be addressed to La Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—June 25th. Tenders are being invited for the supply of 3,000 iron supports, 125 tons of galvanised iron wire, and a quantity of miscellaneous telegraph material. Tenders to be sent to the Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Glasgow.—June 15th. The Caledonian Railway Company requires tenders for stores for the twelve months commencing August 1st. The following are some of the items:—(2) Bolts and nuts; (18) copper rivets; (29) India-rubber; (33) iron rivets; (34) galvanised wire and wire fencing requisites; (49) screws; (50) shovels, spades, and graips; (52) spelter, tin, and lead; (59) sundries; (60) telegraph and electric appliances; (65) tinwork; (66) tools. Specifications, &c., may be obtained on and after June 1st from Mr. Jas. Lorimer, superintendent of stores, Caledonian Railway, Charles Street, St. Rollox, Glasgow.

Huddersfield.—June 19th. Messrs. Learoyd Bros. & Co. require tenders for the supply and erection of a 92-unit direct-current dynamo, and a 3½-unit combined steam-engine and dynamo, at Trafalgar Mills, Huddersfield. Particulars from Messrs. Shepherd and Watney, 71, Albion Street, Leeds.

Jamaica.—Electric tramway constructors willing to undertake the establishment and working of a system of rapid transit (electric) are invited to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. All particulars, plans of the city of Kingston, &c., &c., may be seen at the office of the Crown Agents for the Colonies, Downing Street, London, S.W.

Leeds.—June 22nd. The Council require tenders for an electric installation for working on the overhead system a 7-mile (double track) length of tramways. A note of the seven sections, poles, conduits, wires, cars, accumulators, &c., will be found in our "Official Notices."

London.—June 25th. The Vestry of St. John, Hampstead, wants tenders for the extension of the electric lighting station in the parish stoneyard, Lithos Road, Finchley Road, N.W. For further details apply to the Vestry Clerk.

Mexico.—August 31st. The Municipal Council of Mexico is inviting tenders for the concession for the electric lighting of the public streets during a period of eight years.

Shoreditch.—June 16th. The Vestry invites tenders for the supply and fixing of insulated conduits, cables, switch and fuse boards, &c., &c., for the electric lighting and dust destructor installation. For further details see our "Official Notices."

CLOSED.

Colchester.—From our "Electric Lighting Notes" it will be seen that the Council has accepted the tender of the Electric Construction Company for the establishment of an electric light installation at a cost of £10,675.

Derby.—At the last Council meeting, the seal was affixed to the contract with the British Insulated Wire Company for cables, &c.

Edinburgh.—Messrs. James Waldie & Sons have carried off the contract for supplying coal to the electricity works.

Rochdale.—For installing the electric light at the Free Library, for the Town Council, the tender of Messrs. Peers & Co., at £500, has been accepted.

Wallasey.—The Town Council has accepted the following contracts in connection with the electric lighting installation:—For high and low-tension concentric cable, the British Insulated Wire Company, Limited; transformers, Electric Construction Company, Limited; engines and dynamos, S. Z. de Ferranti, Limited.

NOTES.

The Accident at the Paris Opera House.—It is surprising to find that in many of the daily papers this accident has been ascribed to the heating of the electric wires used for conveying the current to the central chandelier, this heating having been supposed by the writers to be sufficient to melt, by mere proximity, the thick brass cable supporting the counter-balance of the chandelier. The true cause of the disaster was the short circuiting of the electric wires owing to their accidentally coming in contact with the cable supporting the weight, their insulation having been gradually rubbed away. "It may be said," writes M. Bonfante in *Le Génie Moderne*, "that surely the fuse wires would melt, and so prevent the continuance of this heating of the cable." He postpones answering this question until after the inquiry, merely saying that under certain conditions the lead fuses cannot melt, owing to the practice generally adopted of separating conductors of contrary polarity. He holds that in order to bring about their fusion whenever desirable, conductors of contrary nature, although well insulated electrically, should be as near as possible to one another, and in a future article he intends to show that the fusion of a leaden circuit-breaker being the only protection that electricians have against a persistent external calorific action, the conductors should be so arranged as to provoke at the commencement of this external action *a free short circuit between poles*, *i.e.*, the fusion of a circuit breaker.

Mining Engineers.—The Federated Institute of Mining Engineers held its annual meeting at the premises of the Institution of Civil Engineers in Gt. George Street, S.W., last week. Mr. John McLaren read a paper on "Road Locomotives," and Mr. H. W. Ravenshaw submitted one on "Precautions Necessary in the Use of Electricity in Coal Mines."

Röntgen Rays.—What a contemporary calls "a new and unexpected application" of the Röntgen rays is found in their use for ascertaining the contents of suspected infernal machines, Prof. Bronardel, of the Paris Municipal Laboratory, assisted by Messrs. Girard and Bordas, having given an account of their researches in this direction at a recent sitting of the Academy of Sciences.

Lectures.—Before the Oxford Junior Scientific Club, Prof. W. Ramsay delivered the fifth Boyle lecture, on 2nd inst., on "The Position of Argon and Helium among the Elements."

Gas versus Electric Light.—Before the Incorporated Gas Institute annual meeting, held on Tuesday at the rooms of the Society of Arts, Mr. William R. Chester, in the course of his presidential address, dwelt on the rivalry between the electric light and the gas industry. He urged that in the race for public favour the former was being left far behind as an illuminant, and for many years to come was likely to enjoy the equivocal complimentary title of "the light of the future," which no gas engineer would grudge it. The latest returns to the Board of Trade showed that £69,423,431 had been invested in the authorised gas undertakings of the country, which was an increase of £1,750,000 on the previous year. The coal carbonised had been 11,319,301 tons—an increase of 300,000 tons on the previous year. The gas sold had been 105,160,990,000 cubic feet, an increase of 3,274,000,000 cubic feet on the previous year; while the total receipts amount to £19,408,265, and the cost of production to £13,791,520, thus leaving a margin of £5,616,745 gross profit, sufficient to pay 8·1 per cent. on the total capital employed. As to the electric light, it appeared that the total capital invested in the authorised undertakings of the country was £6,470,942, the output of electricity being 24,145,719 Board of Trade units of 1,000 watts each, the total receipts from which amounted to £692,734, and the expenditure to £377,691—leaving a balance of £315,043 as gross profit, which was equal to 4·87 per cent. on the capital employed. The total output of electricity for the whole country was little more than one-half the normal progressive increase in the consumption of gas for one year, or to put it in another way, nearly two additional installations of electric light plant of equal magnitude to the existing one would have to be put down each year before the normal annual growth in the consumption of gas would be arrested, and any serious competition be felt. Though they had now reached the period of practical development of the electric light, and were able to measure its cost and efficiency to a nicety, they were still capable of receiving new shocks of a startling nature, which, if they bore the stamp of sober credibility, might give occasion to review the present unassailable position. But inasmuch as they had grown accustomed to startling sensations of a similar nature in times past, the worst development was hardly likely to cause the purveyors of gas any serious alarm.

New German Cable.—The new 4-wire Government cable to Germany was successfully laid by the India-Rubber, Gutta-Percha, and Telegraph Works Company's cable ship *Silvertown*, between the 25th ult. and the 1st inst. The weather was fairly mild and propitious throughout, though there was at times a heavy ground swell that proved somewhat troublesome. Mr. J. Hookey, Assistant Engineer-in-Chief to the Department, accompanied the ship as the representative of the British Post Office. The total length of the cable is 224 knots. It is laid between Bacton, on the coast of Norfolk, and Borkum Island, off the German coast, at which point it is connected to the German Government wires. The specified resistance of each stranded conductor is 6·625 standard ohms per knot. Each core is separately brass taped to prevent the ravages of the teredo, and to reduce to a minimum the effects of induction from wire to wire. This is a novel provision as far as the cables of the Post Office Telegraph Department are concerned. The deep sea portion of the cable is sheathed with 13 galvanised iron wires of 280 mils. diameter. The shore end portions have additional servings of yarn and compound, and are further protected with a sheathing of 14 strands of iron wire; each strand consisting of three wires of 220 mils. diameter. The cable is the joint property of the German and English Gorvernments. It was manufactured by the India-Rubber, Gutta-Percha and Telegraph Works Company, at their works at Silvertown.

Marriage.—Mr. Frank Iago, the secretary of the Westminster Electric Supply Corporation, Limited, has our cordial good wishes on the occasion of his marriage to Miss Kathleen Richardson. The ceremony was performed at Christ Church, Westminster, on Thursday, June 4th.

Royal Society Conversazione.—Several electrical novelties were exhibited at the Royal Society *Conversazione* on Wednesday last. Prof. Ayrton and Mr. Mather exhibited an instrument for measuring the permeability and hysteresis, consisting of a small dynamo, in which the piece of iron to be tested is inserted as a yoke. The characteristic curve of this small dynamo is then drawn by driving it at a known speed, and measuring the magnetising current, and the E.M.F. produced in the usual way. Mr. J. Frith showed, experimentally, some curious results obtained when a small alternating current is superimposed on a direct current. A large number of Röntgen photographs of the human body were shown by Dr. Macintyre; the photographs of the trunk show some of the internal organs, but leave much room for improvement in sharpness of outline. Prof. S. P. Thompson showed his arrangement for obtaining dust shadows by the Röntgen rays; also a collection of tubes, and Ebert's resonant electric wave apparatus and luminescent lamp. Messrs. Siemens Bros. & Co. had an interesting historical exhibit of vacuum tubes, including *fac-similes* of the earliest (1751) vacuum tubes used for showing the electrical discharge. Mr. Herbert Jackson gave a demonstration of the use of phosphorescent materials in rendering the X rays visible.

The Municipal Electrical Association.—The first Convention of this Association was commenced on Wednesday at the Royal United Service Institution. There was a good gathering of municipal electrical engineers, and some important papers were presented and discussed. As the Association do not desire papers to be published before next week, we shall refrain from saying anything about them till our next issue. Mr. Arthur Wright, of Brighton, presided over the meeting, and, in his Presidential Address, covered the sphere of operations of the municipal electrical engineers. The following papers were afterwards read and discussed:—"Electricity Supply at 220 Volts," by A. S. Barnard, borough electrical engineer, Hull. "Alternating Current Stations and High Voltage Lamps," by Harold W. Couzens, borough electrical engineer, Taunton. "The Control by Municipal Authorities of Consuming Devices, and the Wiring connecting them to the Mains," by Mr. C. H. Wordingham. In the afternoon, the members of the Association visited the works of the London Electric Supply Corporation at Deptford. A similar programme was gone through yesterday, the members visiting the Islington station during the afternoon. To-day the members and visitors visit Brighton, when the proceedings will be continued.

Annual Meeting of the American Institute.—The American Institute of Electrical Engineers held its annual meeting on May 19th and 20th, at the New York Electrical Exposition Building. Dr. Louis Duncan was re-elected president for the year. Papers were read as follows:—Report of Sub-Committee on "Standards of Light," by Dr. Edward L. Nichols, Clayton H. Sharp, and Charles P. Matthews, of Ithaca, N.Y. "An Analysis of Transformer Curves," by Charles K. Huguet, of Pittsburgh. "Effect of Temperature on Insulating Material," by George F. Sever, Ambrose Monell, and C. Langdon Perry, of New York city. "An Experimental Study of Electromotive Forces Induced on Breaking a Circuit," by F. J. A. McKittrick, with Introduction by Dr. E. L. Nichols, of Ithaca, N.Y. "The Production of Electrical Energy for Office Buildings, with Particular Reference to the Plant of the Chicago Board of Trade," by Bion J. Arnold, of Chicago. The Institute has two honorary members, 333 members, and 700 associate members—total, 1,035.

Thunderstorm.—A severe thunderstorm passed over the Newcastle district on Saturday afternoon last, the 6th inst., and a fire that might have led to serious consequences occurred at the Pierce Bridge post office, in the county of Durham. An electrical discharge, carried by the Government telegraph and telephone wires, set fire to the test box in the post office. The fire was promptly put out by means of water drawn from the river Tees close by. Slight damage was done. The wires were quickly joined through by the local engineering staff.

The Royal Society.—Before this Society, yesterday afternoon, a paper was read by Dr. J. A. Fleming, F.R.S., and Prof. J. Dewar, F.R.S., "On the Magnetic Permeability and Hysteresis of Iron at Low Temperatures."

Competition.—A contemporary states that the German Hygienic Association offers a prize of $1,200 for a research essay on the efficiency of electric heaters. The programme is as follows:—"The heat given out in heating installations by heaters in their various forms and modes of use is to be ascertained. The investigations are to be described in detail in respect to the arrangement of the heaters, the nature of the heating agents, and the observations made; and they are to be illustrated by drawings. The heating values obtained are to be stated in units of heat given off per hour per unit of surface. In the case of heat given out to air, the investigations must be conducted with currents of air at speeds as different as possible. The heaters are to be described in detail as regards form and measurement, and the relation of their heating efficiency to their weight is also to be ascertained." Essays are to be written in German, and sent, with a motto and sealed envelope, to Prof. Konrad Hartmann, Charlottenburg, Fasanenstrasse, 18, before July 1st. The essay will remain the property of the successful competitor, but he is required to publish it within six months, and to present the Association with 300 copies. The right to divide or withhold the prize is reserved.

NEW COMPANIES REGISTERED.

Electro-Mechanical Photographic Syndicate, Limited (48,175).—This company was registered on June 2nd with a capital of £25,000, in £1 shares, to acquire, develop, turn to account, and deal with certain patents and patent rights relating to the production and reproduction of photographs, and machinery for the same. The subscribers (with one share each) are: F. P. Stafford, 1, Bernard Terrace, North Woolwich, clerk; A. B. Reeve, 39, Old Broad Street, E.C., clerk; B. Parker, St. Michael's Rectory, Cornhill, solicitor; C. R. Sawyer, 7, Lansdowne Square, Brighton, gentleman; F. Kirby, 39, Old Broad Street, E.C., engineer; D. A. Howden, 72, Holland Park, W., gentleman; A. Hartland, 61, Mansfield Road, N.W., clerk. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first; remuneration, £150 each per annum, and a share in the profits. Registered by Parker and Co., St. Michael's Rectory, Cornhill.

Hermite International Electrical Sanitation Company, Limited (48,232).—This company was registered on June 6th, with a capital of £300,000, in £1 shares, to adopt an agreement with E Hermite, E. J. Paterson, and C. F. Cooper, and to acquire, develop, turn to account, and deal with the several inventions, patents, and patent rights, collectively known as the Hermite patents for bleaching, electrolysing, disinfecting, purifying, and sanitary and other processes. The subscribers (with one share each) are:—E. Hermite, 68, Victoria Street, S.W., electrical engineer; C. F. Cooper, 68, Victoria Street, S.W., civil engineer; F. D. Cooper, 29, Gracechurch Street, E.C., merchant; S. Castle, 14, Southampton Street, Bloomsbury, solicitor; H. W. Kirby, F.C.A., 19, Birchin Lane, E.C.; G. D. Craven, 28, Fenchurch Street, E.C., tea broker; A. E. Cooper, Norbiton Lodge, Kingston-on-Thames, chemist. The number of directors is not to be less than four, nor more than eight; the subscribers are to appoint the first; qualification, £300; remuneration, £2,000 per annum divisable. Registered office, 68, Victoria Street, Westminster.

CITY NOTES.

The Hampstead Accounts.

The most striking feature of the Hampstead accounts is the loss on the undertaking of £2,916 for the 15 months ended December 31st, 1895. Doubtless those that oppose the Vestry's policy of doing their own electric lighting will make the most of this. But in speaking of the heavy loss, one needs to examine most carefully the whole of the period covered by the accounts. The first three months' working from October to December, 1895, have had a very serious influence on the whole of the period under review. For instance, the first quarter's working showed a net deficiency of £838 13s. 7d., while for the corresponding quarter of 1895, after paying proportion of loans and interest, there is a net balance of £315. Of course, the best winter quarter is no criterion of a year's work, but the foregoing figures serve to show that the undertaking is at least making considerable progress.

Mr. Johnson, the Vestry Clerk, has submitted to the Vestry a very complete report of the undertaking since the commencement. He not only dwells upon the 15 months' work, but he goes into the history of the introduction of electric lighting in the parish. The early troubles at Hampstead are notorious, and the Vestry Clerk does not minimise them in any way. It is not necessary to say anything about them, because there is little doubt that they have now completely disappeared. The following table shows the progress that is being made, and with the number of mains now laid there should be a considerable accession of customers. Besides, Hampstead is a rapidly growing neighbourhood, and as many more connections could be made to the present mains without increasing the plant, we see no reason why in two years time the undertaking should not be a really prosperous one.

The cost of production, according to the annexed table, is unduly high, but then one has to remember that wages were paid some weeks prior to the starting of the works, and no doubt a considerable amount of coal was used for trials.

The following table gives the cost per unit:—

	1893.	1894.	1895.
Total capital invested	—	—	£56,522
Number of units sold	—	—	192,527*
Number of lamps connected ...	—	—	19,407
Revenue from sale of current...	—	—	£4,364
Net revenue	—	—	—
Average price obtained per unit	—	—	5·4d.

Loss on undertaking for 15 months to end of December, 1895, £2,916.

* 15 months ended December 31st, 1895.

Cost of production.	£	s.	d.	Per unit.
Coal	2,036	0	0	2·52d.
Oil, waste, water and engine room stores	351	0	0	·44d.
Salaries and wages at generating station	955	0	0	1·18d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	415	0	0	(Works' cost 4·65d.) ·51d.
Rates and taxes	394	0	0	·48d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,196	0	0	1·47d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£5,347	0	0	6·60d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	4,364	0	0	5·4d.
Meter rents	142	0	0	—
Sale of lamps	—			—
Total	£4,506	0	0	5·4d.

Total cost per unit (exclusive of depreciation and renewal accounts), 6·60d.; works' cost, 4·65d.

West African Telegraph Company, Limited.

Sir Henry C. Mance presided at yesterday's meeting at Winchester House. He said the accounts were almost self-explanatory, but he might be permitted to dwell for one moment on perhaps the most satisfactory feature. The gross revenue for the year ending December 31st, 1895, amounted to £74,333, as against £64,761 for the year ending 1894, being an increase of £9,572. The increase in the messages was almost entirely due to receipts derived from the Cape press joint traffic. The total working expenses for 1895 amounted to £17,474, against £17,286 for the previous year, or an increase of £188. The difference in the items was so small, that it was hardly necessary to touch on them in detail. He might say that, notwithstanding the greater volume of business to be dealt with, the efficient system had been fully maintained, without any material increase in the expenditure. The loss on exchange was about the same as the previous year—that was to say, it represented nearly 2½ per cent. on the total share capital of the company. The expenditure relating to repairs to cables was £6,298, as against £13,473 in 1894, a decrease of £7,175. They had, however, not been so lucky under this head since January 1st, 1896, as they had had two repairs of their longest cables. Taking into consideration what had been taken from the reserve fund in the past for repairs, the directors thought it desirable to carry the sum of £15,000 to general reserve, after which they were able to recommend a final dividend of 3 per cent, making, with the interim dividend already paid, a total distribution of 4 per cent. for the year, and carrying the sum of £1,760 forward to next year's account. The reserve fund now amounted to £48,350, and they would see that over £43,000 was actually invested in first-class securities. To show the difficulty they had with regard to the amount required for repairs, he might mention that in 1893 the repairs amounted to £31,234; in 1894 to £13,473, and in 1895 to £6,298. The most expensive section was that which passed the mouth of the Congo, and they would have to take into consideration whether it might be advisable to alter the length of the cable. The immense volume of water from the Congo caused a submarine ravine of enormous depth, this, no

doubt, caused the cable to break so frequently. They were awaiting their engineer's report before deciding on their future policy in connection with the section. He should judge that the receipts for the present year would be quite equal to 1895, but the strain of work had been at times so severe, that they had determined to duplex the whole of the trunk lines of the system, and thus increase their carrying capacity by nearly 100 per cent. They were now engaged in negotiations with the French Government, from whom they received a subsidy of £12,000 a year.

Mr. J. D. Pender seconded the motion, and it was agreed to.

Compagnie Française des Câbles Télégraphiques.

On April 24th the shareholders passed the following resolutions:—

1. The meeting, after hearing the report made by the Administrative Committee, decides to issue, at 4 per cent, 45,000 bonds of 500 francs each, yielding 20 francs per annum at half-yearly payments, redeemable at par at 500 francs in 30 years at latest, with option of earlier repayment; also to apply exclusively to interest, and to redemption of the said bonds, the subsidy of 800,000 francs granted during 30 years to the "Compagnie Française des Câbles Télégraphiques," conformable to the agreement drawn up with the French Government on July 2nd, 1895, and confirmed under date of December 19th of the same year—Act, March 28th, 1896. This subsidy is to be supplemented by such portion of the receipts of the trans-Atlantic cables as will suffice for the said interest and redemption of bonds.

2. The meeting, after hearing the report submitted by the Administrative Committee, decides to issue, at 5 per cent., 30,000 bonds of 500 fr. each, yielding 25 fr. per annum, at half-yearly payments, redeemable at par at 500 fr. in 30 years at latest, with option of earlier repayment.

3. The meeting confers full powers on the Administrative Committee to settle time and conditions in regard to the bonds at 4 per cent. and 5 per cent., the issue of which has been decided on, as well as to take all other necessary measures. The meeting also confirms—as far as may be required—the powers already possessed by the committee in virtue of Art. 22 of the Statutes, for negotiating with credit or banking establishments for the procuring—whilst furthering to the utmost the interests of the company—the funds necessary for effecting submarine telegraphic connections between France, North America, and the Antilles, within time limits laid down in the agreement of July 2nd, 1895, and in the decree of December 19th of the same year.

Electric Traction Company, Limited.

The ordinary general meeting was held on Friday at 16, Great George Street, Westminster. Mr. R. E. Farrant presided.

The Chairman stated that the business of the company to which the directors were at present devoting their attention was the construction and equipment of the Central London Railway, which would run through the heart of London, from Shepherd's Bush to the City, a distance of 6½ miles. This work was undertaken in pursuance of a contract with the railway company dated June 18th, 1895, under which the traction company was to acquire the necessary land and to construct and equip the railway with rolling stock, to be worked by electrical power to the satisfaction of the railway company's engineers, the whole to be completed and delivered by December, 1898. The dominant feature of the report—and it was a feature which they were justified in regarding with great satisfaction—was this—that, having settled the price to be paid for the bulk of the property to be acquired, and having let the contracts for almost the whole of the heavy work, they were satisfied that the undertaking could be carried out within the original estimates, and they had no reason to doubt, unless something altogether unforeseen occurred, that they would complete the railway within the contract time. The stations would be 14 in number, and were placed in the best positions to secure the greatest amount of traffic along the line of route. The Act of Parliament authorising the construction of the line prohibited the making of any openings in the roadways, so that all shafts mut be sunk at the station sites. Their first work, therefore, was necessarily the acquisition of the property required for the stations and depôt at Shepherd's Bush. The acquisition of valuable property, having frontages to the great main thoroughfare in London (he believed Mr. J. S. Forbes once described this route as the greatest traffic thoroughfare in the world), was by no means a simple matter, because of the many interests involved—freeholders, lessees, sub-lessees, tenants, trade interests; in fact, they might judge of the magnitude of their task when he informed them that in respect of the property required for their station sites, and their depôt at Shepherd's Bush, they had had to deal with no fewer than 160 separate claims, amounting in the aggregate to over £700,000. The work of dealing with these claims had been pushed forward with such energy, that at the present time more than four-fifths of the total number of claims had been settled, or had been adjudicated upon by an arbitrator or a jury. He did not think it expedient to state publicly what these settlements had cost them, for there were still about 20 cases to be dealt with. The land estimates were originally framed some years ago, and since then the cost of investments had increased largely, and they had consequently had to pay very heavily for some of the properties of an investment character. Of course, the settlement of the amount of a claim did not mean that they at once got possession. In about half of the total number of cases the purchases had been completed, and they now had complete possession of three station sites, so that there was nothing on this score to prevent the actual work of construction from being very shortly commenced. The line from Shepherd's Bush to the Bank had been divided into six sections. Tenders were invited for the shaft and tunnel work of each section separately, and they had given the sub-contracts as follows:—Sections 1, 2, and 3—Shepherd's Bush to the Marble Arch—Mr. J. Price; sections 4 and 5—the Marble Arch to the Post Office—Messrs. Walter Scott and Co.; and section 6—the Post Office to the Bank—Mr. G. Talbot. In connection with the railway there was to be constructed under the open space in front of the Mansion House and the Royal Exchange a system of public subways, which would also give access from the public streets to the Bank Station. The general idea of this system of subways was approved by the City authorities some time ago, but before they could invite tenders for the work the detailed plans had to be settled. This was a work requiring the utmost care and attention, but they had succeeded in presenting plans which secured the acceptance of the Commissioners of Sewers. The sub-contract for this work had been given to Mr. G. Talbot. He expected that the actual work of construction would be commenced very shortly—he might also say in a few days. The station in the vicinity of Davies Street, and the extension from the Bank to Liverpool Street, were receiving their attention, but he would not dwell on these matters, as they were still in the stage of negotiation. He concluded by moving the adoption of the report and accounts.

Mr. Theodore Davidson seconded the motion, which was carried unanimously.

The Electric and General Investment Company, Limited.

The report of directors, to be submitted to the seventh ordinary general meeting of the shareholders to be held at Winchester House, Old Broad Street, London, E.C. (Hall No. 47), on Thursday, June 18th, 1896, at 2 p.m., states that the profit and loss account shows a gross profit on the transactions of the year of £10,105 6s. 8d., and after deducting all standing charges, the interim dividend already paid on the ordinary shares, and a provision for contingencies of £2,222 16s., there remains a net balance of £5,000 available for distribution. The directors now recommend that this sum be applied to the payment of a further dividend at the rate of 30 per cent. per annum for the past six months, making, with the interim dividend, a distribution of 20 per cent. for the year upon the capital paid up on the ordinary shares, and a dividend on the founders' shares of £20 per share for the year. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share out of the proceeds of investments sold and dividends received in respect of the fund, making, with the before-mentioned dividend, a total distribution of £40 on each founder's share. The directors retiring this year are Mr. George Herring and Mr. B. H. Van Tromp, who, being duly eligible, offer themselves for re-election. The auditor, Mr. G. T. Rait, also retires, but offers himself for re-election. It is proposed to make the dividends payable on June 19th, 1896.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended March 31st, 1896, and payable on the 24th inst. The transfer books will be closed from June 17th to 23rd, both days inclusive.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to—County of London and Brush Provincial Electric Lighting Company, Limited, further issue of 10,000 cumulative 6 per cent. preference shares.

The City of London Electric Lighting Company, Limited.—The board has declared an interim dividend on the preference shares of this company, at the rate of 6 per cent. per annum, for the half year ending June 30th, 1896, payable on and after July 15th next.

Eastern Extension Telegraph Company, Limited.—The directors have declared an interim dividend for the quarter ended March 31st of 2s. 6d. per share, free of income-tax.

Willans & Robinson.—It is stated that the applications for the recent issue of debentures amounted to £250,000, whereas only £100,000 was required.

Commercial Cable Company.—A quarterly dividend of 1¾ per cent. on the capital stock is notified, payable July 1st.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 7th, 1896, were £930; week ending June 9th, 1895, £904; increase, £26; total receipts for half-year, 1896, £21,465; corresponding period, 1895, £21,437; increase, £28.

The Great Northern Telegraph Company. The traffic receipts in May, 1896, amounted to £24,000; 1st January to 31st May, 1896, £114,000; corresponding months, 1895, £124,000; corresponding months, 1894, £105,800.

The Liverpool Overhead Railway Company. The receipts for the week ending June 7th 1896, amounted to £1,152; corresponding week last year (Whit. week), £1,671; decrease, £519.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 5th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,540.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation June 3rd.	Closing Quotation, June 10th.	Business done during week ended June 10th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	102	101
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	10 — 11	10 — 11	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	48 — 50	47 — 49	48½	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	92 — 93	91 — 92	92⅞	91½
2,993,560£	Do. do. Defd.	Stock	...	...	...	8¾ — 9½	8¾ — 9½	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½%	7 %	...	15 — 15½	15 — 15½	15 5/16	15½
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	...	2½%	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 %	1½%	...	3/16 — 5/16	3/16 — 5/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	12⅜	12½
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	19½ — 20½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	106 —109 %	106 —109 %	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2 %	...	9½ — 10	9½ — 10	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17 — 17½	17 — 17½	17⅜	17½
70,000	Do. 6 % Cum. Pref.	10	6 %	6 %	...	18½ — 18¾	18½ — 18¾	18⅝	18½
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	106 —109	106 —109	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	130 —133	131 —134	132⅝	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17½ — 18	17½ — 18	17⅝	17½
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	101 —105	101 —105	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	131 —134	132 —135	134	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	101 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	110 —113 %	110 —113 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝%	4½%	...	10½ — 11	10½ — 11	10⅝	10 9/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17⅛	17½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	23 — 24	23½ — 24½	23⅝	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	52 — 55	52 — 55	...	...
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5 %	5½%	7⅜ — 7⅞	7⅜ — 8	7⅞	7 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16½ — 17½	16½ — 17½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅝ — 6¾	6⅝ — 7	6 11/16	6⅝
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	107 —110	107 —110	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	5 %	9/16 — 11/16	9/16 — 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 — 111	108 —111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	6½ — 7½	6½ — 7½	7 1/16	6 15/16
3,381	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3½ — 4	3½ — 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	7½ — 8½	7½ — 8½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	100 —105	100 — 105	101	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	9 — 9½xd	9 — 9½	9½	9 3/16
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6⅝ — 7½xd	6⅝ — 7½	7	6 15/16
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2½ — 3 xd	2½ — 3	...	...
165,200£	Do. do. do. 6% Debs. "A," 1880 Red.	100	6 %	6 %	6 %	104 —108	105 —109	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	104 —108	105 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	7/8%	1/4%	7/8%	1 — 1½xd	1 — 1½	1¼	1 3/16
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 11½xd	11 — 11½	11½	11½
4,689	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½ — 10½xd	9½ — 10½	10⅜	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	108 —111	109 —112	111	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	£1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	8¼ — 8¾	8¼ — 8¾	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7⅜ — 8	7⅜ — 8	8	7 13/16
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4 %	116 —119	116 —119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14½ — 15½	14½ — 15½	15½	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½ — 17	16½ — 17	16⅞	16⅝
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	134 —138	134 —138	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	*nil*	8½ — 9½	8½ — 9½	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	6 %	12½ — 13½	12½ — 13½	13½	13
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	6 %	8 — 8¼	8 — 8¼	...	
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13½ — 14½	13½ — 14½	13⅞	13½
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —123	120 —123	122½	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	9 — 9½	9 — 9½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	10⅜ — 11¼	10⅜ — 11¼	11	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	9½ — 10	9½ — 10	9 15/16	9 11/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, June 3rd.	Closing Quotation, June 10th.	Business done during week ended June 10th, 1896. Highest.	Lowest.
£0,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	5 % §	2½%	...	1¼ — 1⅜	1¼ — 1⅜	1 3/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1⅝ — 1¾	1⅝ — 1¾	1⅝	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	111 —114	111 —114	...	...
630,000£	City and South London Railway	Stock	1 1/16%	1½%	1 3/16%	42 — 44	42 — 44	43¾	43½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	...	2 — 2½	2 — 2½	2	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1¾ — 1⅞	1¾ — 1⅞	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	2½ — 3½	2½ — 3½	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	1 — 1½	1½ — 1⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2½ — 3	2½ — 3	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¼ — ⅜	¼ — ⅜	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅜ — ⅝	⅜ — ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	10½ — 11½	10½ — 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	16 — 17	16 — 17	16⅞	16¾
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	17 — 18	17 — 18	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	23 — 24	23 — 24	23⅝	23½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —107	105 —107	106½	106⅜
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅝%	14 — 14½	13 15/16 — 14 1/16	14	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	17½ — 17⅝	17½ — 17⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41	38 — 41	40	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8 — 8½	8 — 8½	8⅝	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—6%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 103—106

House-to-House Company (£5 paid), 3¾—4¼.

Do. do. 7 % Preference, of £5, 8⅛—8⅜.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9—9½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½.

Liverpool Electric Supply, £5 (fully paid), 7⅞—8¼.

London Electric Supply Corporation, £5 Ordinary, 1—1¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—8.

Bank rate of discount 2 per cent. (February 22nd, 1894).

ALTERNATE CURRENT DYNAMO-ELECTRIC MACHINES.*

By J. HOPKINSON, F.R.S., and E. WILSON.†

(*Concluded from page* 746.)

Tables II. and III. give for about half and full load (with regard to current only) the data for getting at the watts given out by generator and received by motor, and have been obtained from the potential and current curves. The phase difference between the armatures was $\frac{1}{20}$th and $\frac{1}{10}$th period respectively.

Table IV. shows how the efficiencies of generator, motor, and combination have been obtained; and also gives the allocation of losses in the system.

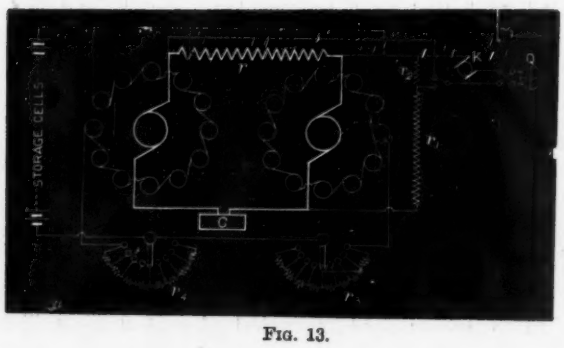
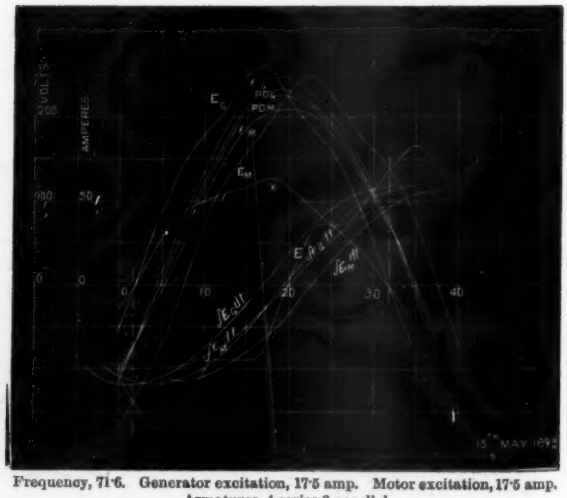


Fig. 13.

The frequency was about 70 periods per second, and, since the machines are built for 100 periods per second, the figures must be taken only as illustrative of the method of test.

The alternators being connected, as shown in fig. 13, we were able to vary the exciting currents of the two machines by means of the adjustable resistances r_3, r_4. The armatures were coupled $\frac{1}{10}$th of a period apart in phase, and the following experiments were made.

1. The alternators were equally excited with a current of 17·5 amperes and run at a speed of 716 revolutions per minute, corresponding with a frequency of 71·6 periods per second, and the following curves obtained (see fig. 14).



Frequency, 71·6. Generator excitation, 17·5 amp. Motor excitation, 17·5 amp. Armatures, 4 series 3 parallel.

Fig. 14.

E_g, E_m are the E.M.Fs. of generator and motor when running on open circuit.

P D_g, P D_m are the potential difference of generator and motor respectively when a current of 42·2 amperes ($\sqrt{\text{mean}^2}$) was passing through the armatures.

e_g, e_m are the E.M.Fs. of the respective machines when loaded, that is to say, they are the curves, P D_g, P D_m, corrected for current into armature resistance.

* Read before the Royal Society, May 2nd, 1895.

† The large majority of the experiments herein described were made in the summer of 1893 and a considerable part of the paper was then written. We have to thank Mr. F. Lydall, one of the student demonstrators at King's College at that time, for much assistance.

TABLE II.—Efficiency Test of Siemens's W. 12 Alternators. Frequency 70·3 Periods Per Second. Half Load.

Angle in 60ths of a period.	Potential at terminals of generator.		Current between machines.			Potential at terminals of motor.		Watts given out by generator.	Watts given to motor.
	Electrometer deflection.	Volts.	Electrometer deflection.	Amperes.	Sq. of amperes $\sqrt{\text{mean}^2}$ = 21·57, Thomson balance 21·68	Difference of potential difference.	Volts.		
0	— 159	— 224	+ 96	+ 23·1	533 6	+ 2 57	— 221·4	— 5,174	— 5,114
2	— 138	— 194 5	+ 76	+ 18·3	334·9	+ 2·03	— 192·5	— 3,559	— 3,523
4	— 119	— 167·7	+ 62	+ 14·9	222·0	+ 1·66	— 166·0	— 2,499	— 2,473
6	— 99	— 139·5	+ 44	+ 10·6	112·3	+ 1·18	— 138·3	— 1,479	— 1,568
8	— 71	— 100·0	+ 17	+ 4·1	16·8	+ 0 45	— 99·5	— 410	— 408
10	— 34	— 47·9	— 18	— 4·3	18 5	— 0·48	— 48·4	+ 206	+ 208
2	+ 6	+ 8·4	— 50	— 12·0	144·0	— 1·34	+ 7·1	— 101	— 85
4	+ 46	+ 64·8	— 79	— 19·0	361·0	— 2·11	+ 62·7	— 1,231	— 1,191
6	+ 79	+ 111·3	— 95	— 22·9	524·4	— 2·54	+ 108·8	— 2,548	— 2,491
8	+ 104	+ 146·5	— 101	— 24·3	590 5	— 2·7	+ 143·8	— 3,560	— 3,494
20	+ 124	+ 174·7	— 107	— 25·8	665·7	— 2·86	+ 171·8	— 4,507	— 4,431
2	+ 145	+ 204·3	— 116	— 27·9	778·4	— 3·1	+ 201·2	— 5,700	— 5,614
4	+ 166	+ 233·9	— 127	— 30·6	936·4	— 3·4	+ 230·5	— 7,158	— 7,053
6	+ 179	+ 252 2	— 129	— 31·1	967 2	— 3·45	+ 248·7	— 7,842	— 7,734
8	+ 174	+ 245 2	— 116	— 27·9	778·4	— 3·1	+ 242 1	— 6,840	— 6,754
					6,984·1			52,402	51,726
					465 6			3,493	3,448

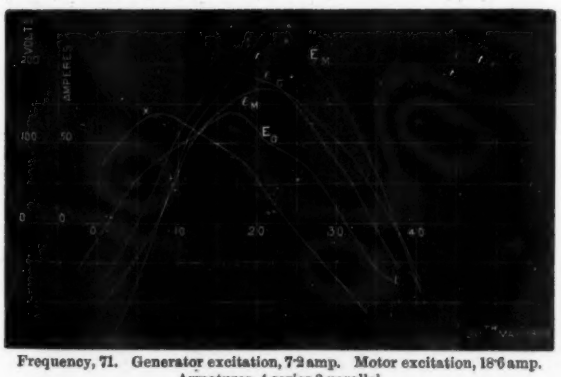
TABLE III.—Efficiency Test of Siemens's W. 12 Alternators. Frequency 69·2 Periods Per Second. Full Load.

Angle in 60ths of a period.	Potential at terminals of generator.		Current between machines.			Potential at terminals of motor.		Watts given out by generator.	Watts given to motor.
	Electrometer deflection.	Volts.	Electrometer deflection.	Amperes.	Sq. of amperes $\sqrt{\text{mean}^2}$ = 42·8, Thomson balance 42·0	Difference of potential difference.	Volts.		
0	— 64	— 90·2	+ 25	+ 6 02	36·24	+ 0·67	— 89·53	— 513	— 539
2	— 35	— 49·3	— 34	— 8·2	67 24	— 0·91	— 50 21	+ 404	+ 412
4	— 1	— 1·4	— 100	— 24·1	580·7	— 2·67	— 4 07	+ 34	+ 98
6	+ 32	+ 45·1	— 152 4	— 36·7	1,347·0	— 4·07	+ 41·03	— 1,655	— 1,506
8	+ 63	+ 88·8	— 189·5	— 45 6	2,079·4	— 5·06	+ 83·74	— 4,019	— 3,819
10	+ 94	+ 132·5	— 211	— 50·8	2,580·8	— 5·64	+ 126·86	— 6,731	— 6,445
2	+ 121	+ 170·5	— 222 4	— 53 6	2,873 0	— 5·95	+ 164·55	— 9,140	— 8,819
4	+ 142	+ 200·1	— 236	— 56 8	3,226·0	— 6·31	+ 193 79	— 11,367	— 11,009
6	+ 155·3	+ 218·8	— 251·5	— 60·6	3,672 0	— 6 73	+ 212 07	— 13,260	— 12,850
8	+ 161·2	+ 227·1	— 251 5	— 60 6	3,672·0	— 6·73	+ 220·37	— 13,763	— 13,354
20	+ 160·2	+ 225 7	— 228·2	— 55	3 023·0	— 6·11	+ 219 59	— 12,413	— 12,080
2	+ 152·4	+ 214·7	— 188·5	— 45·4	2,061·0	— 5 04	+ 209 66	— 9,746	— 9,518
4	+ 138	+ 194·4	— 147·4	— 35·5	1,260 3	— 3·94	+ 190·46	— 6,902	— 6,761
6	+ 118	+ 166·3	— 113	— 27·2	739·8	— 3 62	+ 163 28	— 4,523	— 4,441
8	+ 92	+ 129 6	— 75	— 18 1	327 6	— 2 01	+ 127 59	— 2,346	— 2,309
					27,548·08			96 000	92,940
					1,836 54			6,400	6,196

E is the E.M.F. of the combination when not loaded, that is, it is the difference of the curves E_g, E_m.

x is the curve of current passing between the machines, and is proportional to the E.M.F. (e) of the combination when loaded, the connecting leads being non-inductive. This electromotive force is the difference of the curves e_g e_m.

2. In fig. 15* the frequency is 71, the motor is excited with 18·6 amperes and the generator with 7·2 amperes. In this case the motor is working at higher E.M.F. on open circuit than the generator. Curves corresponding to those in the Experiment 1 were obtained and are marked in a similar manner.



Frequency, 71. Generator excitation, 7·2 amp. Motor excitation, 18·6 amp. Armatures, 4 series 3 parallel.

Fig. 15.

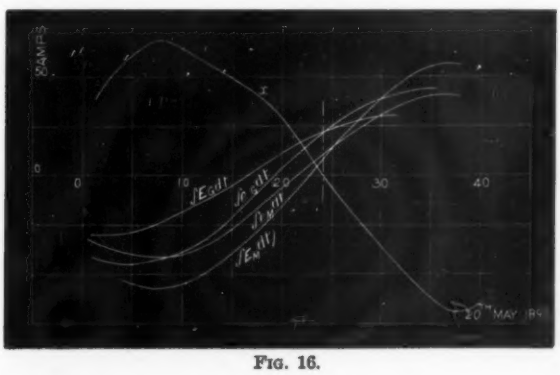


Fig. 16.

The potential curves in fig. 15 have been integrated, and the integral curves so obtained are given in fig. 16. These give therefore the inductions in terms of the time.

3. In fig. 17 the frequency is 70, the generator is excited with 18·6 and the motor with 11·5 amperes. The generator is working with a higher E.M.F. on open circuit than the motor. The potential curves have been integrated, and the integral curves are given in fig. 18.

It was observed that when the exciting current of the motor was decreased, that of the generator being kept fairly constant (the two

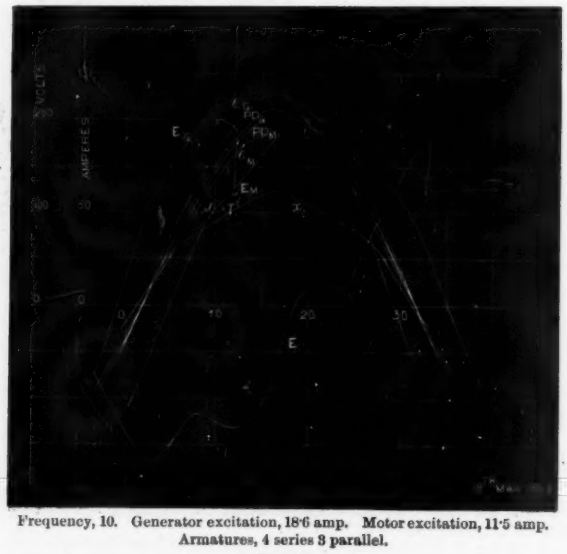
* *Vide* Hopkinson, Institute of Civil Engineers lecture delivered 1883; Institute of Civil Engineers, November, 1884; or "Original Papers on Dynamo Machinery," pp. 58 and 148.

TABLE IV.

No.	Description of magnitude.	Half load.	Full load.
	Frequency in complete periods per second	70·3	69·2
	Phase difference between armatures in fractions of a complete period	$\frac{1}{20}$	$\frac{1}{10}$
1	Watts given out by generator (see Tables II. and III.)	3,493	6,400
2	Watts given to motor (see Tables II. and III.)	3,448	6,196
3	Watts dissipated in generator armature = $(\sqrt{\text{mean}^2}\ \text{C.})^2 \cdot 275$ ohm	128·5	481·2
4	Watts dissipated in motor armature = $(\sqrt{\text{mean}^2}\ \text{C.})^2 \cdot 275$ ohm	128·5	481·2
5	Watts dissipated in generator magnet winding	537	537
6	Watts dissipated in motor magnet winding	537	537
7	Watts dissipated in connections between machines	45	204
8	Watts absorbed by combination through belt	1,848	2,941
9	Total electrical power developed in generator = No. 1 + No. 3	3,621	6,881
10	Half watts absorbed by system *minus* half known watts = $\frac{1}{2}\{\text{No. 8} - (\text{No. 3} + \text{No. 4} + \text{No. 7})\}$	746	889
11	Total power given to generator = No. 5 + No. 9 + No. 10	4,904	8,307
12	Percentage efficiency of generator = $\frac{\text{No. 1}}{\text{No. 11}} \times \frac{1}{100}$	71·2	77·0
13	Percentage loss in generator armature	2·61	5·79
14	Percentage loss in generator magnet winding	10·9	6·46
15	Percentage sum of all other losses in generator	15·29	9·75
16	Percentage efficiency of motor = $\left(\frac{\text{No. 9} + \text{No. 10} - \text{No. 8}}{\text{No. 2} + \text{No. 6}}\right)\frac{1}{100}$	63·2	71·7
17	Percentage loss in motor armature	3·22	7·14
18	Percentage loss in motor magnet winding	13·5	7·98
19	Percentage sum of all other losses in motor	20·1	13·18
20	Percentage efficiency of combination = (No. 12 × No. 16) $\frac{1}{100}$	45·0	55·2

TABLE V.

Angle in 60ths of a period.	Current in genr. mags. 18·2, motor 18, $\sqrt{\text{mean}^2}$ volts on motor 155. Frequency 70.				Current in genr. mags. 18·6, motor 11·5, $\sqrt{\text{mean}^2}$ volts on motor 143. Frequency 70.				Current in genr. mags. 19, motor 8·4, $\sqrt{\text{mean}^2}$ volts on motor 132·5. Frequency 70.			
	Volts $\sqrt{\text{mean}^2} = 153$.	Current. Electrometer deflection.	Current. Amperes $\sqrt{\text{mean}^2} = 49·3$.	Watts given out by generator.	Volts $\sqrt{\text{mean}^2} = 146$.	Current. Electrometer deflection.	Current. Amperes $\sqrt{\text{mean}^2} = 40·5$.	Watts given out by generator.	Volts $\sqrt{\text{mean}^2} = 135·5$.	Current. Electrometer deflection.	Current. Amperes $\sqrt{\text{mean}^2} = 49·6$.	Watts given out by generator.
0	− 53·3	44	− 9·9	+ 528	− 33·8	42	+ 9·45	− 319	− 23·8	124	+ 27·9	− 664
3	+ 13·6	155·3	−35·0	− 476	+ 23·3	51	−11·48	− 267	+ 34·4	4	+ 0·9	+ 310
6	+ 75·9	219·4	−49·4	− 3,750	+ 80·3	138	−31·06	− 2,494	+ 81·2	88	−19·8	− 1,608
9	+146·8	249·5	−56·2	− 8,250	+134·2	182·5	−41·08	− 5,513	+127·5	143·5	−32·3	− 4,118
12	+192·6	263·5	−59·3	−11,420	+179·6	222·3	−50·05	− 8,988	+167·5	202·2	−45·5	− 7,622
15	+219·7	277	−62·4	−13,710	× 206·2	265·5	−59·76	−12,320	+188·4	263·5	−59·3	−11,170
18	+224·2	251	−56·5	−12,670	+205·2	267·5	−60·22	−12,360	+184·2	282·8	−63·7	−11,730
21	+203·2	188·4	−42·4	− 8,616	+186·6	231·2	−52·04	− 9,710	+165·4	263·5	−59·3	− 9,808
24	+166·6	128	−28·8	− 4,798	+150·6	194·2	−43·72	− 6,584	+132·3	245·5	−55·3	− 7,316
27	+108·6	53	−11·9	− 1,292	+ 96·2	141·5	−31·85	− 3,064	+ 80·4	205	−46·1	− 3,706
				64,454				61,919				57,432



Frequency, 10. Generator excitation, 18·6 amp. Motor excitation, 11·5 amp. Armatures, 4 series 3 parallel.

FIG. 17.

machines being equally excited with about 18 amperes each to begin with), the current between the machines gradually decreased until a critical point was reached, when a further diminution of the motor exciting current had the effect of increasing the current between the machines.* It was also observed that the watts given out by the generator did not vary in the proportion of the currents between the machines.

Table V. gives the watts given out by generator for three values of its exciting currents 18·2, 18·6, and 19 amperes, the corresponding

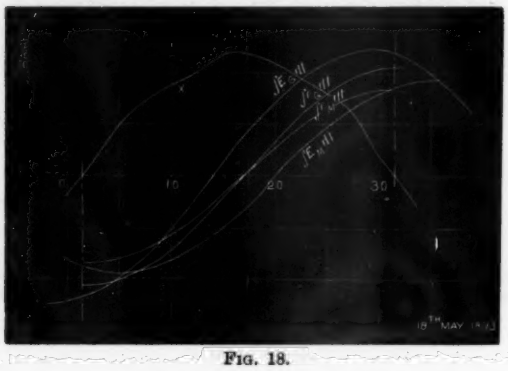


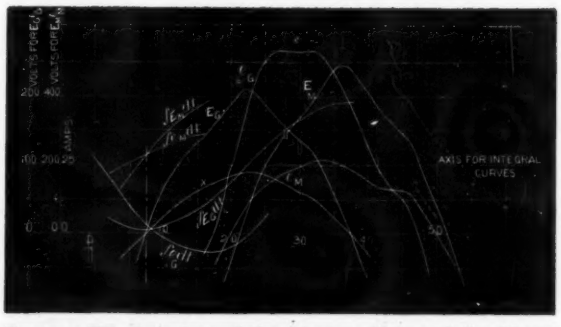
FIG. 18.

exciting currents for the motor being 18, 11·5, and 8·4 amperes. The current between the machines is a minimum for exciting currents of 18·6 and 11·5 in the two machines, and the curves in fig. 17 have been taken under these conditions.

* This effect has been independently observed by Mr. Mordey and Mr. Kapp (see *Journal of Institute of Electrical Engineers*, Vol. XXII., pp. 128, 173).

This is a point of practical importance in transmission of power by alternate currents, since the size of the conductor between motor and generator is mainly determined by the current transmitted. The cause is readily explained from the curves.

Starting with the conditions as in Experiments 2, where the motor is more highly excited than the generator, we see that the current (x) is accelerated in phase with regard to the potential difference of the machines. On increasing the exciting current of the generator until the machines are equally excited as in Experiment 1, the current (x) is still accelerated with regard to the potential difference, but not to such an extent. On diminishing the motor exciting current until the machines are excited as in Experiment 3, the current (x) is in phase with the potential difference. For a given power transmitted this will be the point of maximum efficiency with regard to the intermediate conductors. Any further diminution of the motor exciting current has the effect of retarding the current (x) with regard to the potential difference, and consequently for the same watts transmitted and the same potential difference the current must be increased. The



Frequency, 70·7. Generator excitation, 3·3 amps. Motor excitation, 8·6 amps. Armatures, all series. Motor inductions plotted to ½ scale of generator.

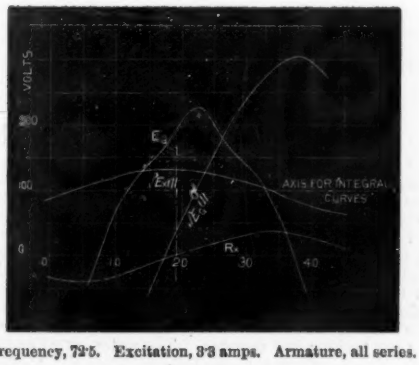
Fig. 19.

case in which the conductors between motor and generator have considerable induction or capacity has not been worked out.

The losses in the system can be supplied electrically (instead of by belt as in these experiments) as in the case of direct current machines.*

III.

The results of the last section are valuable in relation to the effects of induced currents in the magnets, the subject of Section I. With a machine working as a simple generator the current lags behind the electromotive force on open circuit by any amount from 0° to 90°. But when a generator and motor are run rigidly coupled together, the current may lead the generator electromotive force, or may lag and the motor may lag by any amount from 90° to 270°. Regarding the



Frequency, 72·5. Excitation, 3·3 amps. Armature, all series.

Fig. 20.

relative phases of electromotive force of machines and of current, the machine is a generator when the current is from 0° to 90° behind the machine; it is a motor from 90° to 270°; and again a generator from 270° to 360°. We have already stated that we should naturally expect that the induced currents in the magnets would have little or no effect when E.M.F. and current were in the same phase, and that they would have a maximum effect when the two were 90° apart, or at quarter centres. We should expect further that, as a generator can be made into a motor by reversing the current in the armature, wherever local currents diminish E.M.F. of a generator, they would increase E.M.F. of a motor. That is, we should expect that local currents would diminish E.M.F. from lead 0° to 180°, and increase E.M.F. from 180° to 360°. As a fact, we find this to be partially verified; it seems that local currents diminish E.M.F. from a negative angle of comparative small amount, perhaps 30°, to considerably more than 90°, and that they increase E.M.F. from 180° to over 270°.

Referring to the curves in fig. 14, x and $\mathfrak{E}_y$ are in phase, and $\int e_y\,dt$ would need increasing 3 per cent. to meet $\int \mathfrak{E}_y\,dt$, and when x vanishes $\mathfrak{E}_m$ lags 216°, and $\int e_m\,dt$ needs diminishing, that is the currents have increased the E.M.F. In fig. 15 a very small change in the observations would change the character of the results.

We have taken another set of curves shown in figs. 19 and 20. In fig. 19 we have a very small current 3·3 amperes in the generator magnets, and the current is in phase with the generator, the motor being 264° behind the current. The generator is about 12 per cent. low owing to local currents, and the motor is 25 per cent. of its actual value high. To obtain a better standard we excited a machine with 3·3 amperes and passed the same current as before through the arma-

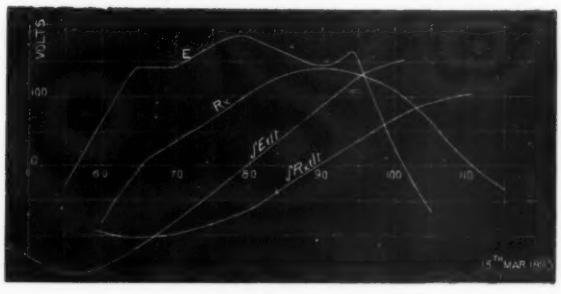


Fig. 21.

ture and an ordinary non-inductive resistance, and found the current lagged 72°, and the E.M.F. of the machine was diminished 50 per cent. instead of 12 per cent. The results are given in fig. 20.

In considering the applications of these results, it must be remembered that the machines have been worked far outside the limits of practice for the purpose of accentuating the effect. If we confined ourselves to these limits we should still find these effects, but smaller in amount.

* See *Engineering*, March 24th, 1893.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

THE UTILISATION OF WATER-POWER, ESPECIALLY WITH A SMALL FALL, WITH SOME EXAMPLES OF PLANTS FOR THE GENERATION OF ELECTRICAL ENERGY. By ALPH. STEIGER. (Paper read May 28th, 1896.)

(*Concluded from page* 744.)

The power is transmitted from the turbine on to a horizontal main shaft by means of a pair of bevel wheels. This horizontal shaft is made to run at 75 revolutions, and is provided with a clutch by means of which the turbine is connected with the steam engine if the mill is required to work continuously. When the fall is reduced to more than 32 inches, the mill is, however, driven separately by the steam engine, and the power of the turbine is used to drive the wheat-cleaning machinery, and eventually some pairs of millstones which can work independent of the automatic roller mill plant. When the fall is reduced to 15 inches, the power that is still obtained from this turbine is 7 H.P., the turbine naturally running slower; but still this power is quite sufficient to be profitably utilised.

Assuming that the water-power available at Brantham Mills were applied for the generation of electric energy, it would, in the first instance, be necessary to obtain a conveniently high speed to drive an electrical generator without much intermediate gearing. A turbine similar to the one actually working could be made for exactly these conditions, running at 30 revolutions per minute, and a pair of bevel wheels put in of such proportions as to give the first motion shaft a speed of 150 revolutions per minute. This speed would be very suitable to drive a dynamo of 40 H.P. by means of a belt or ropes. A higher speed of the turbine than 30 revolutions would, for such a low fall, only be obtainable at the expense of efficiency. As in this special case the fall, and consequently the power, varies with the rise and fall of the tide, the full power of the turbine can, of course, only be relied on during 15 or 16 hours every day. The power produced during the time when the fall is diminished beyond the limit at which it is 40 H.P., and at less than the normal speed, could probably be applied to charge electrical accumulators.

The construction of the turbine shaft deserves some notice. The space underneath the turbine being always filled with water, and therefore inaccessible, the pan for the footstep is placed on top of a

column, round which the hollow cast-iron shaft revolves. The upper part of the turbine shaft is widened, and contains an adjustable steel pin, which revolves in the pan or cup filled with oil. Although a well-constructed footstep will last for years without requiring repairs, an easy access to it is of great advantage.

Similar turbines were erected by me in other mills near Norwich, Reading and Lewes. In all cases the fall varies between (23 inches) 2 feet 6 inches and 6 feet, the reduction of the fall being caused by floods, while the water supply varies in the proportion of about 1 to 4. In each case the local conditions were carefully investigated, and the turbine constructed accordingly. The good results obtained in each case are due to the careful *adaptation* of the turbine to the conditions. The importance of a careful consideration of local conditions is evidenced by several failures which were recently brought under my notice. In one of these instances the turbine, which in itself is a very good motor, gives very poor results, owing to the disregard of the actual conditions of the locality. Even the construction of some details of a turbine depends sometimes on these conditions, and in several cases now under consideration, I have had to depart from the general practice of designs of turbines, in order to secure the highest results when most required.

How varied the construction of a Jonval turbine may be, will be shown by the following examples.

The turbines of the Geneva Waterworks, built by Messrs. Escher, Wyss and Co., of Zurich, work under a maximum fall of 12 feet during the winter season, when the water supply is shortest, while during the summer season the water supply stored up in the mountains, in the shape of snow and ice, is abundant. The large summer supply reduces the fall, however, to 5 feet 7 inches. The power of each turbine, of which there are now 17 at work, is 210 actual H.P., and they run at a uniform speed of 36 revolutions per minute, whether the fall is 5 feet 7 inches or 12 feet. The cost in this case was a secondary question; the turbines have, therefore, been provided with the best possible arrangements to suit the large variations of the fall and quantity of water.

The drawing shows three concentric rows of buckets. The outer row alone will develop 210 H.P. under the maximum fall of 12 feet

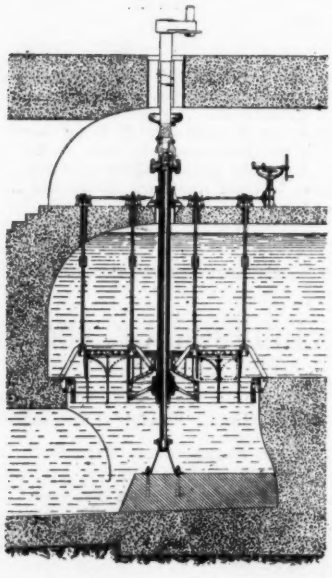


Fig. 6.—Turbines at the Waterworks, Geneva.

—its outside diameter is 14 feet. Each of the two inner rows of buckets is provided with a revolving gate, working separately. Each turbine drives a pair of double-acting plunger pumps direct, the crank common to both pumps being fixed on the vertical turbine shaft.

An interesting turbine installation, under a fall varying from 10 feet 9 inches to 8 feet 10 inches, in connection with electrical generators, is that at Baden, in Switzerland. It was described in *Engineering* of November 1st, 1895. This plant was erected to supply the town of Baden with electric light, and the necessary driving power to the new works of Messrs. Brown, Boveri & Co., the well-known electrical engineering firm. The fall had to be created by a weir, and a canal about 2,500 feet long, which added considerably to the cost of the plant. Each of the three turbines is of the Jonval type, giving off 200 B.H.P. It is impossible to build a turbine of that power for the fall available in this case, which would run with a speed high enough to drive a generator direct. The turbines run at 40 revolutions per minute, which speed is maintained under the varying fall by means of gates for the inner row of buckets. The generators—two-phase dynamos of the horizontal type, made by Messrs. Brown, Boveri & Co.—run at 200 revolutions per minute, and are driven direct off the turbine shaft by means of a pair of bevel wheels. The exciter dynamos, of which there are three of 10 H.P. each, are driven each by a separate turbine. These small-power turbines naturally run at a higher speed—namely, 180 revolutions per minute—and drive, therefore, the exciter dynamos without any intermediate gearing.

In most cases in this country, where a good water supply is available, the fall will be rather lower than 10 or 12 feet; it will, therefore, require intermediate gearing to drive a high-power generator, and it will even not often be possible to connect it direct with the first main shaft driven off the turbine by bevel wheels. Belt drives are very convenient to get up the necessary speed of dynamos, but for large power they are very expensive, and absorb a considerable amount of the power in friction. The ordinary round hemp and cotton rope is objectionable, on account of requiring frequent repairs and re-splicing. During an inspecting tour in Switzerland last summer, I came across a new kind of hemp rope, which seems to supply just what is wanted to drive large power dynamos. A piece of this patent rope is here for inspection. It is a plaited rope of extreme pliability, which does not stretch. I found this rope working at the generating station of Schaffhausen. The power at the generating station is transmitted from the countershafts, driven off two turbines of 300 H.P. each by means of bevel wheels on to the generators, by means of 10 such ropes, $1\frac{3}{4}$ inches thick. The rope pulleys on the dynamos have a diameter of 5 feet, running 300 revolutions per minute. The rope pulleys on the countershaft have a diameter of 13 feet 6 inches, and the distance between the centres of shafts is 51 feet. The power is electrically transmitted to a spinning mill about half a mile distant from the generating station. The secondary station consists of an electromotor of 200 H.P., coupled directly to a main line shaft, and two electromotors of 100 H.P. each, coupled together. The latter, running at 300 revolutions per minute, carry a rope pulley of 5 feet diameter, with 14 grooves. 100 H.P. are transmitted by four such ropes to a shaft 21 feet above the electromotor, at an angle of 51°, while the remaining 250 H.P. are transmitted to another shaft on about the same level, and 17 feet 8 inches distant, running with 130 revolutions per minute. In spite of the unfavourable relative position of the shafts, these ropes work with extreme regularity and easiness, and their adaptation has, according to the manager of the spinning mill, put an end to the trouble and frequent stoppages caused by the breaking of the round ropes which were previously used.

Returning to the description of water-power plants proper, two more examples in connection with the generation of electricity deserve to be mentioned, showing how certain objects can be attained by a special construction. One of these is the installation of five new turbines for the aluminium works at Neuhausen, on the Rhine fall, in Switzerland. One of these turbines is here illustrated. Each of these turbines gives off 610 B.H.P. under a fall of 66 feet, with a quantity of water of 6,500 cubic feet per minute.

With the high fall a high speed suitable for driving the dynamo direct is naturally obtained—an arrangement which has also been

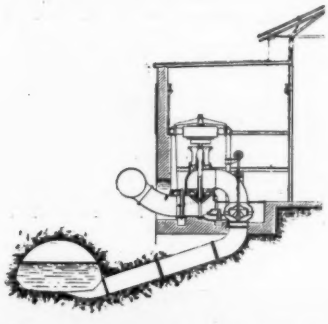


Fig. 7.—Turbines at the Aluminium Works at Neuhausen, Switzerland.

adopted in this case to economise space. On the other hand, the load on the footstep of a turbine of the power mentioned by the pressure of the water, in addition to the weight of the armature of a generator of corresponding dimensions, is so great that a special arrangement had to be adopted to release the footstep of at least a part of that load. In order to overcome this difficulty, the turbine has been reversed, the water passing through the turbine upwards, acting, therefore, in the opposite direction to the weight of the machinery. The boss of the turbine wheel is, moreover, formed into a piston, working in a cylinder, to which water under the pressure corresponding to the fall is admitted, thus counteracting again the weight of the moving parts of the turbine and dynamo. The water, after passing through the turbine, is conducted to the tail-race through a suction tube, the tube being placed 15 feet 9 inches above the tail-water. It runs at 150 revolutions per minute, and is a single Jonval turbine. To regulate its speed, if required, a ring gate is inserted in the suction tube, while it can be stopped by a throttle valve in the wrought-iron tube taking the water to the turbine. The total power now utilised by these aluminium works is 4,550 H.P. The turbines were constructed by Messrs. Escher, Wyss & Co., of Zurich, and the dynamos by the well-known electrical works at Oerlikon. Each dynamo is of 7,500 amperes and 55 volts.

The last turbine installation here illustrated is that at Zufikon-Bremgarten, also in Switzerland. The drawing shows another arrangement to counteract the weight carried by the footstep, and at the same time an arrangement by means of which the necessary speed to drive a dynamo of large power direct under a medium fall is obtained.

The plant consists of four sets of double Jonval turbines of 325 B.H.P. each, running at 115 revolutions per minute, and a smaller Jonval turbine of 34 B.H.P., driving two exciter dynamos, running with 210 revolutions per minute, and was erected to supply electric light to the neighbouring town of Wohlen, and driving power to the new works of Messrs. Escher, Wyss & Co., in Zurich, and a large flour mill close by these works. The distance over which this power is transmitted is about 11 miles.

The fall is 17 feet 6 inches, and was obtained by building a dam across the river Reuss, and a tunnel about 1,100 feet long across a hill round which the river flows at a rather high speed. The water is divided between two Jonval turbines fixed on one common shaft, so that it passes upwards through the lower wheel and downwards through the upper wheel. By distributing the water in this manner the diameter of each turbine is reduced, and the speed consequently increased. At the same time the pressure of the water, which would otherwise act on the footstep, is entirely counterbalanced. The central part of the lower wheel is, moreover, formed into a disc, on which the water presses from below, releasing the footstep also partly by the weight of the revolving parts of the turbine and the dynamo. The space between the two turbines on each shaft is connected with the tail-race by a flume formed of concrete, which acts as a suction tube. This turbine plant was also erected by Messrs. Escher, Wyss, and Co., and the dynamos were built by the Oerlikon works.

The examples given above of the utilisation of water power may be considered as representative types of successful installations under different conditions. They are sufficient in number and in variety to prove the necessity of a selection from motors which are different in principle, and of the careful adaptation of the turbine selected to the local conditions and requirements.

A turbine installation under a low fall will be more costly than one under a higher fall; it is, consequently, of special importance to obtain the highest possible efficiency, even at an extra expense, under a low fall. The cost of the turbine itself is only a fraction of the total outlay for the plant, including foundations, connection with the machinery to be driven, and sometimes a weir and a canal. The cost of these permanent structures exceeds that of the motor; it is, therefore, a penny wise and pound foolish policy, after putting in the permanent structure, to try and cut expenses by putting in a turbine of insufficient capacity or inferior efficiency. The commercial value of a water power depends rather more on the annual outlay on the same than on the first cost, and the annual outlay for the work obtained from the power is the smaller the higher the efficiency of the plant.

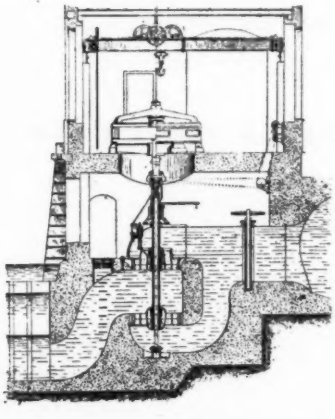


FIG. 8.—TURBINES AT ZUFIKON-BREMGARTEN, SWITZERLAND.

The efficiency of a turbine which can be obtained and honestly guaranteed, even if the fall is low, is about 75 per cent. Eighty per cent., and a little over, is sometimes obtained under favourable conditions, and has been proved by careful tests made by responsible experts; but an efficiency of 85 and 90 per cent., sometimes claimed, is never reached, if the quantity of water be *accurately* measured during the test. If the efficiency of the turbine is guaranteed at all, it should be stated not only for the most favourable conditions, but also for a reasonable *minimum* of the fall or the quantity of water.

In many instances within my own knowledge, water power, in itself sufficient to drive the machinery of a factory, but improperly utilised, is supplemented by artificial power, produced by steam, gas, or oil engines. The loss of money caused by the waste of the cheap power from a running stream in this manner amounts, certainly, to a big sum in this country alone. The annual cost of such auxiliary power, calculated for 3,000 working hours, may be put at three to four times the cost of water power, and calculated for 6,000 working hours, four to eight times the cost of water power. A judicious utilisation of the water power in such cases would not only result in an enormous saving of money, but in a gain of a large amount of power now unutilised. Most factories are closed at night time, when the water is allowed to run away without being made use of. Assuming that the water power is insufficient to drive all the machinery in the day time, while it is wasted during the night, electrical storage batteries in connection with a generator might very advantageously, and, perhaps, with greater economy, be used instead of auxiliary steam, gas, or oil engines.

It seems probable that in the near future the electrical transmission of power will take the place of shafting and belt drives in factories, when certainly the waste of water power would be prevented in the manner suggested. Owners of factories driven by water power might even find that by improving their water power they obtain spare power which could be profitably applied by the generation and distribution of electrical energy in the immediate neighbourhood.

I may add that the majority of large power central stations now being erected in Switzerland for the generation and distribution of electrical energy, are mostly utilising small or medium falls, varying between 10 to 30 feet. The storage of water in the shape of snow and ice on our mountains, provides us with a good water supply during the summer; but the low temperature in winter reduces that water supply very considerably. The water power there is just as variable as in other countries, and those falls which can be advantageously utilised on account of being situated in the inhabited and industrial districts are often not any higher, or not much higher, than in this country; the only difference being that such small falls occur more frequently, rendering a concentration of large power in one place easier, and perhaps less costly. Still, it is my conviction that concentration of water power for the distribution of electrical energy, or for the generation of a large amount of electric current, as required for electro-chemical and electro-metallurgical processes, is possible in many places in this country without going into prohibitive expenditure for canals, &c.

In conclusion, I hope I have succeeded in my endeavour to show how water power under low falls can be, and is, very advantageously and economically utilised for the generation of electrical energy; and that a very large amount of water power is now running to waste which could, in conjunction with electrical machinery and apparatus, be turned to profitable account by such a hearty co-operation of the electrical and the water-power engineer as has resulted in such success of commercial enterprise in my native country.

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR SPECIAL CORRESPONDENT.]

THE Charters Towers (Queensland) Electric Supply Company, Limited, having been successfully floated, the contract for the first instalment of plant has been awarded to the Crompton Electric Supply Company. The original specification called for the supply and erection in working order, in the town of Charters Towers, of boilers, steam engines, dynamos, mains, &c., for an electric supply station capable of producing sufficient energy to light simultaneously 2,000 lamps of 8 C.P. (30 watt lamps). The plant to be supplied, consisting of two boilers, for a working pressure of 120 lbs. per square inch, capable of evaporating 2,000 lbs. of water per hour, with the feed water at a temperature of 60° F., with all fittings, injectors, duplex feed pump, feed water heater, ring steam pipes, &c.; one 40-kilowatt set, and one 25-kilowatt set of direct coupled engines and dynamos, underground mains and feeders, transformers, switchboards, instruments, &c. The dynamos to generate an alternatiug current at a pressure of 2,200 volts. The following tenders were received on this specification:—Messrs. Edge & Edge, of Sydney, £6,540, for either Oerlikon or Electric Construction Company's dynamos and Willans engines; Brush Electric Engineering Company, £7,020, for Willans engines, or £7,330 for Falcon engines; Crompton Electric Supply Company, £6,789, Browett and Lindley's engines. Ultimately, it was decided to commence with one set only of 40 kilowatts capacity, and Messrs. Crompton & Co.'s amended tender of £5,100 was accepted. The boilers will be made by Messrs. Evans, Anderson & Phelan, of Brisbane, and Korting injector and Pearn's duplex feed pump used; part only of the ring main steam pipes being required.

The area to be lighted is about 1¼ square miles, the station being situated at the corner of the town, but fairly near the centre of the mining district. The present capacity (*i.e.*, 1,200 8-C.P. lamps), of the plant is already subscribed for, and an addition will have to be made very soon. Provision is to be made for the addition of two more 40-kilowatt units, and one 25-kilowatt unit. The principal demand for lighting at present is in Gill and Mosman Streets, which run at right angles to each other. Two high tension feeders are provided for in the first contract, one transformer pit being in Gill Street, at a point about 57 chains from the station, and the other at the junction of Mosman and Gill Streets, 1 mile from the station. The farthest point at present to which distributing mains will extend is about 1¼ mile from the central station. All cables to be placed underground; lead covered steel armoured cables, of Callender and Co.'s make, are to be employed, laid direct in the ground, to be laid, wherever possible, under the footways, at a minimum depth of 12 inches, and not less than 24 inches where laid under roadways.

The insulation of feeders is specified to be not less than 5,000 megohms between positive and negative conductors, and not less than 2,500 megohms between either conductor and earth; the insulation resistance of distributing mains being specified at not less than 1,000 megohms. The feeders are to be 19/18 concentric, and distributing mains triple concentric. In the first contract provision is only made for distributing mains in Gill and Mosman Streets. The charge is to be by meter entirely at 1s. per unit, gas being 13s. 6d. per 1,000 net; and the use of demand meters is contemplated. This will be the

first central station in Australia to charge entirely by meter. As coal is 30s. per ton, the boilers are to be constructed to burn wood. A railway siding is to be constructed to run right up to the furnace doors.

The use of 220 volt distribution is contemplated, and as a trial the company's offices are to be lighted with 220-volt lamps run from the outer wires of the three-wire secondary system. The transformers will be wound to give 220 volts on the secondary with intermediate connection for third wire, and provision is made for placing a second transformer in the pit in the event of increasing the secondary pressure, the feeders supplying at 2,200 volts. There is at present no street lighting. The consulting engineer is Mr. Jas. O. Callender, A.I.E.E., who has been given a very free hand. The whole of the work is to be carried out in strict accordance with the Rules and Regulations drawn up by the Committee of the Postal Conference in Melbourne in November, 1894, and very stringent installation rules are to be put in force in view of the proposed use of 220-volt service.

The Crompton Company have also secured the contract for a small central station for the town of Narrabri—principally street lighting.

A small plant of four arc lamps and 70 incandescents has just been installed by the Brush Company at the Great Cobar Copper Mine, principally in the engine house and smelters, the successful running of which has fired the inhabitants of Cobar with a desire for a central station, and the Municipal Council is now considering the question.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

11,387. "An improved electrical locking and unlocking railway signal apparatus." A. G. Horne. Dated May 26th.

11,391. "Improvements in cut-outs for electrical uses." J. C. Reynolds. Dated May 26th.

11,413. "Improvements in pneumatic telephones." J. C. Chalmers. Dated May 26th.

11,417. "Improved means for electrically connecting the rails or sections of electric railways." R. C. Brown and Franklin E. Huntress. Dated May 26th.

11,419. "Devices for electrically lighting the wick of oil lamps." H. D. Fitzpatrick. (The Empire Self Lighting Oil Lamp Company, United States.) Dated May 26th.

11,421. "Improvements in dynamos and electromotors, and in the gearing of same." J. D. F. Andrews. Dated May 26th.

11,429. "Improvements in and connected with electric brakes for electrically propelled vehicles." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated May 26th.

11,441. "Improvements in electric arc lamps." T. E. Adams. Dated May 26th.

11,451. "Improvements in apparatus for producing musical sounds by electricity." W. P. Thompson. (G. Breed and C. A. Bragg, United States.) Dated May 26th.

11,471. "Improvements in arc lamps for alternating current circuits." W. L. Wise. (A. B. Fernald and J. H. Hubbell, United States.) Dated May 26th.

11,473. "Improvements in electric railways or tramways." J. C. Love and J. E. Hodges. Dated May 26th.

11,481. "Improvements in the driving of machinery, vehicles, boats, &c., by electric motors or other high speed motors." T. Tomlinson. Dated May 27th.

11,517. "Improvements in or relating to the application of electric light to carriage or other lamps." H. A. Bessemer. Dated May 27th.

11,519. "Improvements in or relating to induction coils, alternating current motors, transformers, dynamos, and other machines depending upon the principle of electrical induction." R. J. Crowley and A. B. Hutchings. Dated May 27th.

11,521. "A new electrical signal of the signal house at the railway station." W. M. Klees. Dated May 27th.

11,553. "Improvements in the manufacture and production of filaments for incandescent electric lamps." J. W. Swan. Dated May 27th.

11,617. "An improved electric alarm for railway trains and other purposes." H. Binko. Dated May 28th.

11,627. "Improvements in secondary batteries." E. J. Clubbe, W. Southey, and The Electric Motive Power Company, Limited. Dated May 28th.

11,647. "Improvements relating to electric couplings." E. Theodora (Lady Forbes). Dated May 28th.

11,710. "An improved electrical method of joining metallic and other tubes, pipes, bars, and the like." W. L. Poole, A. Stone, and A. St. Vincent Turquand. Dated May 29th.

11,724. "Improvements in the manufacture of electrical hot plates and other apparatus designed for electrical production of heat." A. E. Woodhouse. Dated May 29th.

11,730. "An improved apparatus for producing galvanic or electrolytic depositions." W. P. Thompson. (The Elektra Galvanoplasticke Anstalt, H. Teith, and A. Floeck, Germany.) Dated May 29th.

11,732. "An improved plate for storage batteries." F. Grunwald. Dated May 29th.

11,779. "Electric arc lamp." J. G. Lorrain. (J. McLaughlin, United States.) Dated May 30th.

11,783. "Improvements in electric railways." H. H. Lake. (G. Ferraris and R. Arno, Italy.) Dated May 30th.

11,800. "Improvements in coin-freed electric meters for the measurement of electricity." J. Atherton, G. Knight, and G. Ellis. Dated May 30th.

11,801. "Improvements in sockets or holders for electric incandescent lamps." J. Katzenstein. Dated May 30th.

PATENTS OF 1882 EXPIRING IN JUNE, 1896.

We are informed by Messrs. W. P. Thompson & Co. that about 65 applications for electrical patents were filed in the month of June, 1882, A.D. Only one of the patents granted on these applications has been maintained for its full term, and, being of considerable interest, we give a short abstract of it below:—

2,818. "Preparation of plates for secondary batteries." J. Scudamore Sellon. Dated June 15th, 1882. This invention consists in making perforations or interstices in these plates of such a form that they lock or firmly retain in position the material with which the plates are packed. Single or double cones, either curved or straight, are used as the shape of these perforations.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps.*)]

1895.

8,507. "Improvements in, and relating to, cut-outs." J. A. Jeckell. Dated April 30th, 1895. Relates to the combination of a fuse cut-out and a disconnecting plug in one, in such manner that the fuse wire mounted in a carrier acts as a safety fuse and current connecting plug when inserted, and as a current disconnecting plug when withdrawn, thus operating as two separate instruments in one apparatus, combined with a provision in double-pole fuses for preventing "short-circuiting by accident or negligence." 1 claim.

8,727. "Improvements in switches for varying electrical resistance." Siemens Bros. & Co., Limited, and H. H. Lauckert. Dated May 2nd, 1895. Relates to a circular switch for varying electrical resistance, in which are used two or more brushes insulated from each other except through a resistance, these brushes being of such width and so arranged relatively to the conducting segments over which they are moved, and which are themselves connected through successive resistances, so that in some positions of the brushes they introduce into the circuit the resistances through which they are connected to each other. 2 claims.

8,914. "Improvements in the preparation of chloride of lead for use in electrical storage batteries, and for other purposes." A. R. Davies. Dated May 4th, 1895. Relates to the method of preparing chloride of lead by dissolving oxide of lead in hot dilute hydrochloric acid, allowing the solution to cool to cause the bulk of the chloride of lead to separate out, adding more hydrochloric acid when necessary to the cooled liquor, and after reheating this, using it to dissolve more oxide of lead, and so on repeatedly. 1 claim.

1896.

4,844. "Improvements in electric arc lamps." T. E. Adams. Dated March 3rd, 1896. Relates to the combination in an electric arc lamp with the carbon rod, and a clutch having jaws disposed at diametrically opposite sides of rod, these jaws having graphite facings, these facings being adapted to receive the carbon rod between them to engage the same at diametrically opposite points. 1 claim.